PROCEEDINGS

Fifty-Second Annual Convention

OF THE

American Railway Bridge and Building Association

1947

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Proceedings of the

Fifty-Second Annual Convention

OF THE

American Railway Bridge and Building Association

Held at

CHICAGO, ILLINOIS

September 16-18, 1947

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Baltimore & Ohio, Garrett, Ind.

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Elise LaChance ..... Secretary
431 S. Dearborn, Chicago

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Illinois Central (retired), Chicago

The Executive Committee Consists of the Officers and the Following

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TABLE OF CONTENTS

PAGE

Running Story of Convention 5

Election of Officers 7

Abstracts of Addresses by:
President F. G. Campbell 6

J. H. Aydelott 6

Ralph Budd 8

George D. Gaw 8

Report of Treasurer 9

Report of Secretary 9

List of Past Officers Since Organization 56

Constitution and By-Laws 66

Directory of Members:
Active Members 76

Life Members 90

Charter Member 92

Honorary Members 94

Associate Members 94

Membership by Roads 102

Bridge and Building Supply Men's Exhibit 116

List of Advertisers 118

Addresses and Committee Reports

Construction and Maintenance of Shop and Enginehouse Floors and Runways (Report) 10

Economies to be Derived through the Modernization of Obsolete Water Stations (Report) 14

Utilization of New Types of Material in Buildings (Report) 19

Recent Tests on Determination of Impact and Stresses in Steel, Masonry and Timber Bridges—By *E. J. Ruble* 25

Unfilled Needs in Power Machines and Power Tools for Bridge and Building Work (Report) 30

Development and Training of Supervisory Personnel in Bridge and Building and Water Service Forces (Report) 33

Inspection of Substructures and Underwater Foundations (Report) 37

Safety Measures to Protect Employees Within Buildings Against Fire and Accidents (Report) 43

Glued, Laminated Members in Bridges (Report) 48

PROCEEDINGS

This account of the 1947 convention contains a general report of the various activities during the three-day meeting; abstracts of all the addresses read at the meeting, including those presented during the joint sessions with the Roadmasters' Association; and complete versions of all of the committee reports, with brief abstracts of the discussions that followed their presentation.

EVIDENCE that the American Railway Bridge and Building Association is a force of increasing potency in furthering the railroads' efforts to assure adequate, modern structures, economically maintained, to serve their various needs, was present in abundance at Chicago on September 16-18. At that time the association held its fifty-second annual convention, a meeting that possessed all the elements necessary to an outstanding affair. The more important of these ingredients included a highly constructive program of committee reports and addresses, and an excellent attendance with the "frosting on the cake" being provided in the form of a high degree of interest manifested in the proceedings by all of those present.

Doubtless contributing to a considerable extent to the success of the meeting was the fact that, continuing a precedent established last year, it was held concurrently under the same roof (the Stevens hotel) with the annual convention of the Roadmasters' and Maintenance of Way Association, the activities of which were reported in the October issue. Experience with this arrangement during the two years it has prevailed revealed a number of advantages, including the fact that members of one group have the opportunity of participating in any programs of the other that may be of particular interest to them. While the meetings of the two groups were for the most part held entirely separate from each other, the groups were brought together on two occasions, including the opening session, to participate in programs of mutual interest.

Attendance Above Last Year

Not the least encouraging feature of the meetings was the fact that during the three-day period they were in session a total of 765 members and guests registered their attendance. This figure is considerably larger than the registration of 693 last year—a registration which, incidentally, was considered excellent at the time.

Affording an interesting sidelight on the meetings, and serving also as a further indication of the widespread interest attracted by them, was the fact that nine technical committees of the American Railway Engineering Association scheduled meetings to be held in Chicago while the conventions were in session, thus enabling the members of these committees to participate in any programs of interest to them.

Not to be overlooked in any account of the activities of the week is the large joint exhibit of manufacturers' products that was presented in the exhibit hall of the hotel jointly by the Track Supply Association and the Bridge and Building Supply Men's Association. With a total of 96 companies partici-

pating this exhibit was even larger than the record display that was staged last year by 90 firms.

The combined opening session of the conventions was presided over jointly by F. G. Campbell, chief engineer, Elgin, Joliet & Eastern, and president of the Bridge and Building Association, and by E. J. Brown, engineer of track, Burlington Lines, and president of the Roadmasters' group. Mr. Campbell and Mr. Brown also functioned jointly in directing the activities of another joint session held on Wednesday afternoon. All separate sessions of the Bridge and Building group were presided over by Mr. Campbell, assisted by J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton (first vice-president), and E. H. Barnhart, division engineer, Baltimore & Ohio (second vice-president).

Greetings from Other Groups

The opening session, as reported in the October issue, was devoted in part to words of greeting from the American Railway Engineering Association by Armstrong Chinn, president, Terminal Railroad Association of St Louis, and president of the A.R.E.A.; from the Track Supply Association by H. M. McFarlane, president of that association; from the Bridge and Building Supply Men's Association by W. L. McDaniel, president of that group; and from Lewis Thomas, secretary of the Track Supply Association and director of exhibits for both supply groups.

The final feature on the program of the joint opening session was an address by J. H. Aydelott, vice-president, Operations and Maintenance department, Association of American Railroads. At a subsequent joint session the two groups were addressed by Ralph Budd, president, Burlington Lines, who spoke on Problems of Railway Management and How Our Groups Can Help. The program of this same joint session also included two motion pictures. One of these, entitled Suggestions Unlimited, dealt with the Illinois Central's employee suggestion system, and was presented through the courtesy of that road. The other, entitled Maintenance of Way Mishaps, was shown through the courtesy of the Southern Pacific.

President Campbell Comments

After calling the separate session of the Bridge and Building Association to order, President Campbell reviewed the history of the association, pointing out that it is nearly half as old as the railroad industry itself. Noting that the members, in discharging their responsibilities, are having to cope with shortages of materials and labor, at a time when costs of both are going up, he said that it is the responsibility and duty of the members to seek solutions to the problems thus presented. This can only be done, he said, by more efficient operation, based largely on the further development of labor-saving machines. Reporting on the year's activities of the association, President Campbell said that, in at least one respect—the procurement of new members—it was one of the best years ever experienced by the organization. An active membership campaign, he said, resulted in the recruiting of 97 new active members and 13 new associate members. As a result, he said, the association now has a total of 568 dues-paying members.

Ensuing separate sessions of the Bridge and Building Association were given over in large part to the presentation and consideration of eight technical committee reports and two addresses, which together dealt with a broad cross-section of the problems facing the men in this group. The committee reports covered the following subjects: Economies To Be Derived Through the Modernization of Obsolete Water Stations; Construction and Maintenance of Shops and Enginehouse Floors and Runways; Development and Training of Supervisory Personnel in Bridge and Building and Water Service Forces; Glued, Laminated Members in Bridges; Unfilled Needs in Power Machines and Power Tools for Bridge and Building Work; Safety Measures to Protect Employees Within Buildings Against Fire and Accidents; Utilization of New Types of Material in Buildings; and Inspection of Substructures and Underwater Foundations.

Of the two addresses that were presented, one was delivered by E. J. Ruble, structural engineer, research staff, Association of American Railroads, on Recent Tests on Determination of Impact and Stresses in Steel, Masonry and Timber Bridges. The other address, entitled The Power of Color, was presented by George D. Gaw, director, Color Research Institute of America.

Published in full in the following pages are all of the committee reports, with brief abstracts of the discussions

that followed their presentation. Also included are brief abstracts of the addresses by Mr. Aydelott, Mr. Budd (both presented at the joint sessions), and Mr. Gaw. In addition, a shortened version of the address by Mr. Ruble is presented.

Special Events Add Interest

Interest was added to the meeting by a number of special events. One of these was the presentation of an honorary membership certificate to Charles H. Buford, executive vice-president, Chicago, Milwaukee, St. Paul & Pacific, who was elected to this capacity at last year's meeting. Also, action taken at the meeting this year resulted in the election of one new honorary member, namely, Clarence R. Knowles, superintendent of water service (retired), Illinois Central, who has been active in the work of the association for many years, having served as president in 1921-22.

Other special events included the annual banquet held on Wednesday night, which was a joint affair with the Roadmasters and was attended by a total of 984 persons; and an inspection trip on Thursday afternoon, also joint with the Roadmasters, to the Carnegie-Illinois steel plant of the United States Steel Corporation at Gary, Ind.

New Officers Elected

In the election of officers to serve during the coming year, Mr. Hancock was advanced from first vice-president to president; Mr. Barnhart was advanced from second vice-president to first vice-president; W. F. Martens, general foreman, bridges, buildings and water service, Atchison, Topeka & Santa Fe, San Bernardino, Calif., was advanced from third vice-president to second vice-president; W. A. Huckstep, general building supervisor, Missouri Pacific, St. Louis, Mo., was promoted from fourth vice-president to third vice-president; Guy E. Martin, superintendent water service, Illinois Central, Chicago, was elected fourth vice-president; and Mr. Knowles and Elise LaChance were re-elected treasurer and secretary, respectively. The new directors elected were: Lee Mayfield, resident engineer, Missouri Pacific, Houston, Tex.; Franz M. Misch, general bridge and building supervisor, Southern Pacific, San Francisco, Calif. and W. D. Gibson, assistant engineer, Burlington Lines, Chicago.

Eight subjects were chosen for investigation by committees during the ensuing year, as follows: Protection to Bridges Over Navigable Streams; Types of Bridges for Replacing Timber Trestles; Enlarging and Relining Tunnels for Present-Day Traffic; Recent Developments in Storage and Servicing Facilities for Diesel and Oil-Burning Locomotives; Sanitary Facilities and Appurtenances for Railway Buildings; Eliminating Waste of Water; Good Housekeeping to Promote Safety and Fire Protection; and Housing Bridge and Building Employees.

Because of widespread satisfaction with the plan of holding this convention concurrently with that of the Roadmasters' Association, the decision has been made to continue the arrangement next year. The tentative date for the 1948 meeting is September 21-23.

"Only Salvation" Is More Machines

THE problems confronting the railroads, and the part that maintenance officers must play in coping with them, constituted the theme of Mr. Aydelott's paper before the joint opening session. Referring obliquely to the present predicament in which the railroads find themselves because of rising costs, he said, "it is fortunate for our country and for those of us who are connected with the railroad industry that our great system of railroads was built and perfected some years ago," explaining that at present-day costs of both labor and materials "even the most courageous of investors would scarcely undertake the risk that would be involved in financing the construction of a railroad plant. . . ."

Mr. Aydelott emphasized the magnitude of the 15½-cent-an-hour increase recently awarded maintenance of way employees, by saying it represents "the hourly rate of pay of this group when he was in construction service 30 years ago. Moreover," he said, "every article that is purchased for maintenance and construction purposes has had a price increase of 50 to 80 per cent, and some items have increased in price even more." He added that the outcome of the railroads' present case for higher rates will contain the "answer to the question of whether our American railroads will remain solvent or whether they will pass into the hands of the government."

Mr. Aydelott regards mechanization in the maintenance of way department as "your only salvation if our plant is to be maintained to the necessary high standard on reasonable budgets." If the present pace toward mechanization is continued, he is of the opinion that the result will be still greater productivity by a smaller force, "although we will have to find ways and means to eliminate those delays which reduce the productive time. . . ."

Turning to a consideration of the safety problem, Mr. Aydelott said that the solution is "an undertaking which will require a strong cooperative effort, not only to make our maintenance employees conscious of their own responsibility but, in addition, to find some way of giving them greater security against accidents, particularly when on movements to and from work and in the operation of machines that make considerable noise."

Budd Condemns Railroads' Detractors

IN HIS address before the joint session on Wednesday afternoon, Mr. Budd stated that he would like to speak a little about "what is right with the railroads." One of the things that Mr. Budd feels is right with the railroads is that their "tracks and fixed properties generally are maintained to a much higher standard than ever before." In making this statement he was referring to the capacity for handling large trains safely at high speeds being "aware that not enough tons of steel rail have been laid in the tracks in recent years to offset the wear and tear of heavy traffic."

Another thing that is right with the railroads, in Mr. Budd's opinion, is the present capitalization of the railroad systems of the country as a whole. While it has been popular to say that the railroads' trouble is that they are over-capitalized, he said that this has probably never been the case. As proof of this statement only one figure need be cited, he asserted, this being the total interest on all funded debt of the railroads in the United States, which now amounts to about $400 million a year. The most recent increase in wages for railway employees, he said, amounts to more than all the yearly interest on the funded debt of all the railroads of the country—and this increase followed a similar increase of even larger proportions that went into effect only a year ago.

Mr. Budd does not think that the general welfare is well served when anyone exaggerates the effect of the railroads being unable to meet, 100 per cent, the immediate requirements of any extraordinary demand for cars. The same inability to fill orders 100 per cent in every other industry is accepted as a matter of course, he said. "We wait for delivery of a new automobile without thinking the automobile factories have broken down."

Mr. Budd also touched on the improvements that have been made in the railroad plant, making it possible for them to handle 64 per cent more ton-miles of freight during World War II than they handled in 1929, even though the number of cars and locomotives at their disposal was substantially less. He spoke, furthermore, of the urgent need for the Interstate Commerce Commission to act promptly and favorably on the pending application for an emergency increase of 10 per cent in freight rates.

Power of Color

The address by Mr. Gaw on the Power of Color revealed some surprising attributes of color, including its psychological effect on human beings. The psychological power of color, said Mr. Gaw, is predicated on its exact hue. In other words the effect from a cold red (red and blue) is very different from that of a warm red (red and yellow), while a green blue will not affect us the same as will a purple blue.

Red is the most stimulating of colors, said Mr. Gaw, while yellow produces the sensation of sunlight, and blue is the coldest of the colors. To indicate what he meant by these properties Mr. Gaw went on to describe case histories demonstrating the power of color over the physical and emotional well-being of human beings.

Yellow has the best visibility of all colors and plays an important part in accident prevention, he said. Explaining that yellow and black comprise the most effective combination for visibility, Mr. Gaw said that this combination is best where quick attention is essential and where reading at a distance is a factor. However it should never be employed where legibility is needed because it is cutting to the eyes and will not hold sustained attention, he asserted.

Color planning for modern industry

embraces, in addition to the psychological factors, the symbolic values and the visibility aspects of colors. In other words, said Mr. Gaw, we associate red with danger and green with nature and safety, etc., and these associations have become part of the subconscious mind. Confusing visibility with legibility is one of the common errors made in color usage today, he said.

Explaining the uses of color in industry, Mr. Gaw said that there are some general color principles that can be applied to all working places. Except in special cases, he said, plant ceilings are painted white because this is the color that reflects maximum light. White is not used on walls, he said, because workers should be surrounded by colors that should make them feel at ease and do not cause eye fatigue. The color on the walls must be in keeping,

TREASURER'S REPORT

Cash balance September 1, 1946		$ 454.90
RECEIPTS: —		
Dues	$1,763.50	
Advertising	85.00	
Miscellaneous (Refund)	5.78	
	1,854.28	
Total Receipts		$2,309.18
Disbursements:		
Salaries	$600.00	
Social Security Tax	6.00	
Stationery & Printing	287.76	
Postage	90.00	
Rent, Phone, Electric Light	202.67	
Miscellaneous	48.28	
Bond Coverage	10.00	
1946 Convention Expense	92.91	
	1,337.62	
Balance on hand August 31, 1947		$ 971.56

RECONCILIATION:
Bank Balance September 1, 1947—$971.56.

Signed—C. R. KNOWLES, Treasurer.

SECRETARY'S REPORT

Active members—September 15, 1946		*362
New members since September 15, 1946	97	
Total	459	
Reported deceased since September 15, 1946	6	
Resigned since September 15, 1946	5	
Transferred to life membership	3	
Dropped—Members from whom we have not heard, who served in Armed Forces 1941-46, incl., whose dues were waived for duration by action of Executive committee	15	
Total	29	
Total active members, September 15, 1947		430
Associate members, September 15, 1946	123	
New associate members since September 15,1946	13	
Total	136	
Dropped account non-payment of dues	2	
Total associate members, September 15, 1947		134
Life members, September 15, 1946	82	
Elected to life membership since September 15, 1946	3	
Total	85	
Reported deceased since September 15, 1946	2	
Total life members, September 15, 1947		83
Honorary Members		4
Total membership as of September 15, 1947		651

* Does not include 85 members dropped account inactive since 1941 or earlier—also does not include 22 new members approved at close of 1946 convention—total 107 members.

he asserted, with those on the machines and should be in harmony with the function of the establishment.

In a plant that has a scientifically-designed color scheme, said Mr. Gaw, everything in the place—walls, ceilings and machines—are treated with colors that aid production. Such a design, he said, results in more accurate and faster work, happier and less-tired employees, a lower accident rate, and better relations with employees.

Construction and Maintenance of Shop and Enginehouse Floors and Runways

Report of Committee

R. W. Gilmore (chairman), gen. br. insp., B.&O., Cincinnati, Ohio; A. R. Harris (vice-chairman), engr. br., C.&N.W., Chicago; James J. Winn (vice-chairman), supvr. b.&b., B.&M., Boston, Mass.; C. Kenneth Avery, B. J. Many Inc., Detroit, Mich.; R. E. Baker, supvr. b.&b., C.&E.I., Danville, Ill.; Maurice Coburn, sales engr. Indianapolis, Ind.; W. A. Huckstep, gen. bldg. supvr., M.P., St. Louis, Mo.; E. S. Joehnk, asst. engr. constr. & maint., B.&O.C.T., Chicago; Edward B. Jones, asst. supvr. b.&b., C &O., Clifton Forge, Va.; S. E. Kvenberg, asst. engr., C.M. St.P.&P., Chicago; F. H. Masters, ch. engr. (retired), E.J.&E., Joliet, Ill.; W. J. Storen, W. J. Storen Company, Detroit, Mich., and J. L. Varker, div. engr., D.&H., Carbondale, Pa.

IN view of present high construction costs and the necessity that every dollar spent assure the maximum return, this is an important subject for consideration by this association. It is important, too, because in the last few years the wear and tear on shop and enginehouse floors has become much more severe, due to the heavier loads being hauled and the fact that they are moved by mobile cranes and tractors.

When floors become rough and uneven they are not only objectionable to work on, but moving loads and cranes cannot be safely operated over them. Shop committees are much more aggressive today and insist on good, well-drained floors.

This report is not an attempt to write a specification, but represents the ideas of various members of the committee as to the best practice in the construction and maintenance of the various, most commonly used types of floors.

The subject divides itself in two parts, first, floors in shops and enginehouses which are under roof and not subject to weather, and second, runways and platforms, not under roof. The various types of construction for floors considered in this report include brick, wood block, bituminous mixtures and concrete.

Brick Floors

Brick floors, if constructed of hard brick, are thoroughly satisfactory for shop floors which are not subjected to much heavy trucking. As long as the bricks are not too badly worn, and have not been treated with a mortar filler, they are fairly easy to surface; however, after the bricks have become worn they cannot be surfaced or pathed satisfactorily. Brick floors should never be laid without a concrete sub-base. This base should be from 6 in. to 8 in. thick, depending upon the character of the subsoil and the traffic to which the floor is to be subjected. The sub-base can be reinforced with mesh if desired, but this is not necessary where there is good soil beneath it. The top of the base should be 1½ in. to 2 in. below the bottom of the brick and this space should be filled with sand for a cushion. The sand should be carefully leveled off and the bricks laid on it by hand.

There are two methods of treating the joints between the bricks. The best method is to fill them with hot tar, thus preventing water and other substances from getting between the bricks. Another method is to cover the floor with cement grout and sweep this around over the bricks until the joints are filled. This latter method makes a better floor temporarily, but, after the bricks are worn, it is practically impossible to take them up and re-lay them.

Creosote-treated wood blocks are fairly satisfactory for floors in back and machine shops where they are not subjected to much water. They should never be used in roundhouses, as an excessive amount of water on the blocks causes

them to swell, and the floor will soon become uneven. The construction of wood block floors follows closely that of brick, in that they should have an adequate sub-base of concrete. Some wood block floors have a sand filler under the blocks, but this is not necessary. Blocks can also be applied to the concrete base. The base is treated with a primer, followed by a ⅛-in. coat of coal-tar pitch. The blocks are laid after this has hardened, and should be set with the grain vertical. After they are laid, they should be given a top dressing of hot pitch filler.

Floors constructed of bituminous concrete or asphaltic compounds should never be used in roundhouses or shops where they are subject to oils, grease, or hot water, and their construction will not be discussed here.

Concrete Floors

Concrete floors are the most satisfactory, if properly constructed. After their completion, however, it is almost impossible to make any improvement in them; hence the utmost care should be taken to see that good workmanship and materials are used in their construction. It is recommended that every member interested in this subject read carefully the booklet published by the Portland Cement Association, titled, "Concrete Floor Finishes." In this it is stated that the essentials for good floor surfaces are:

Careful Selection of Materials
Skilled Supervision
Workmanship

Often, some of us have very little control over the selection of materials, these being governed by geography and other conditions. However, we can insist that the grading and cleanliness of the aggregates be reasonably good. The supervision is up to us. The workmanship is also governed by our desire for better construction, and our ability, through leadership, to educate and instill the same desire in our staffs and our subordinates.

Most of the following discussion on concrete floors will be confined to those built on the ground, or to the topping of old floors. When floors are built on the ground, the sub-grade should be properly prepared. It should be well and uniformly compacted: all sod should be removed. Where it is necessary to fill, the fill should be built up in layers, not exceeding 6 in., and should be thoroughly tamped or rolled. This applies also to pipe trenches and holes for footings. Care should be used in the selection of the material to be used for these fills, which should not contain large lumps, frozen material, or anything which will rot.

Before the slab is poured, the subgrade should be in a moist condition. It should be sprinkled prior to doing the work, but there should be no pools of water, and it should not be muddy or soft when the concrete is placed.

The thickness of the slab and the necessity of providing reinforcing in it depend upon the bearing capacity of the sub-soil and the traffic to which the floor is to be subjected. It is our recommendation that no floor be cast less than 6 in. thick, and that for heavy traffic the thickness should be at least 8 in.

Placing Concrete Floors

In the construction of floors covering large areas, some provision should be made for expansion. This can be accomplished by frequent construction joints or by using an asphaltic filler, construction joints should be provided around all walls and columns.

The Portland Cement Association recommends that the concrete for the slab should be made of hard, well-graded aggregates and should contain not more than 6 gal. of water for each sack of cement. However, it is the opinion of your committee that water should be limited to not more than 5⅛ gal. It should be a plastic mix which can be placed without honeycombing or permitting excess water to accumulate on the surface. The actual mix of the concrete will vary to a great extent with the size and moisture content of the aggregate, as well as other factors. Therefore, it is not possible to give exact directions in this discussion. This information is given in detail in specifications of American Railway Engineering Association and the Portland Cement Association.

The concrete should be thoroughly compacted by vibrating or by tamping and spading. Tamping is very important wherever the top of the slab is to be the wearing surface. After this, it should be screeded and floated to proper grade, and then allowed to stand until all water sheen has disappeared before troweling. The use of a mechanical float permits the placing and finishing of much stiffer concrete and, at the same time, results in much better wearing qualities.

Topping Course

The majority of your committee believes that fairly good floors can be obtained without topping; however, the Portland Cement Association recommends topping courses be applied to all heavy-duty floors. This is pointed out in its booklet called, "Concrete Floor Finishes", referred to previously.

Space does not permit presentation here of all the information contained in this booklet, but some of the main recommendations follow:

"If the base has hardened, or the finish course is being applied to an old floor, it should be approximately 1 in. thick, and never less than ¾ in. In either case, the base should be thoroughly roughened before applying the topping. It should be well brushed, cleaned and free from all laitance and scum. The base should be thoroughly watered, but there should be no pools of water on the surface.

"The fine aggregate should consist of clean hard sand, all of which should pass a ⅜-in. sieve and only 5 per cent being permitted to pass a No. 100 sieve. The coarse aggregate should be graded so as to pass a ½-in. sieve, and only 5 per cent to pass a No. 8 sieve. It, of course, should be as hard as possible, and should be free from dust, clay, loam or vegetable matter, or any coating which would weaken the concrete."

The recommended mixture should be one part portland cement, one part of fine aggregate, and two parts of coarse aggregate, by volume. This, of course, can be varied depending upon local conditions. In case the aggregate is very coarse, its volume may be reduced, but should not be less than 1½ times the volume of the fine. A maximum of 5 gal. of mixing water, including moisture in the aggregate, to a sack of cement, is recommended. The Portland Cement Association recommends at least 1½ min. in the mixer.

Application

Before applying the topping coat, a thin coat of neat cement grout should be broomed into the base surface. This should be so applied that it will not harden before the topping is applied. After pouring the top and striking off the surface to a plane about ⅜ in. above the established grade, it should be compacted by tamping. This is very important, as a much denser finish is secured by thorough tamping. The surface should then be floated with a wood float or power floating machine. After the floating, steel troweling should be done after the surface has hardened sufficiently to prevent any excess fine material from working to the surface. If a rough surface is desired, it should then be brushed with a stiff brush.

Although the P.S.A. recommends that no dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the wearing course to absorb moisture or to stiffen the mix, this is a subject which is in dispute. Some members of your committee believe that, if properly handled, this is not detrimental and that "shakes" of some patented hardening material are extremely beneficial if used properly.

When floors are to be subject to extremely hard wear, such as in wheel shops, etc., investigation should be made into the use of iron, natural and prepared topping aggregates or hex-grids.

Curing

The curing of the concrete floor is one of the most important operations in its construction, as a good floor can be spoiled if it is not properly cured. Curing can be done with curing compounds, or by covering the concrete with wet sand, pools of water, or wet burlap.

Your attention is called to the specification for heavy-duty floor construction and paving, dated June 1, 1945, as prepared by the Chicago, Milwaukee, St. Paul & Pacific. This specification is very good. The special points wherein it differs from the specification of the Portland Cement Association are that it calls for the use of air-entraining cement and graded trap rock aggregate. The Milwaukee's specification for screeding is also very good, in that it calls for screeding of the topping ¼ in. above the existing pavement, or the proposed grade, and that the topping be tamped down to grade.

Enginehouse Pits

This discussion would not be complete without reference to construction details for enginehouse pits. Formerly, pits were constructed with short wood ties supporting the running rails and wood jacking planks spiked to these ties. More modern practice is abandoning the wood ties and jack planks. Many roads are designing pits with concrete supports

for the rail, the rail being held to gage by anchor bolts in the concrete. Concrete jacking pads are also being used.

Old pits with wood ties can be modernized when the floor is being rebuilt by the substitution of short pieces of rail in the wood tie pockets. These rail ties should be placed base up and the running rail clipped to them. Jacking pads can then be cast over the tops of these rail ties. The floor slab should be formed a sufficient distance from the outside of the running rail to permit access to the rail clip bolts. This space should be filled with a 6-in. by 6-in. treated wood plank.

Patching Concrete Floors

It is more difficult to patch concrete floors properly than any of the other types. For this class of work, reference is made to "Concrete Floor Finishes," of the Portland Cement Association, pages 21 and 22; also to Volume 43, "Journal of the American Concrete Institute," October, 1946, titled, "Wear Resistance Tests on Concrete Floors and Methods of Dust Prevention."

In the former, recommendations are made for patching, particular stress being put on the fact that patches should be cut out at least 1 in. depth for the full area to be patched, and that no attempt be made to feather edge the patch; all corners should be square. Also, the material should be screed off higher than the finished floor and tamped to place. The same attention should be given to curing as recommended previously. It is suggested for dusting floors that the top chalky surface be removed by scrubbing with steel wool pads and then that some type of commercial hardener be applied.

Runways and Platforms

Runways and platforms not under roof include walks or paved driveways, paths between various buildings, or various permanent installations and material platforms in shop areas. This is not meant to include station platforms or similar facilities. The committee believes that brick or woodblock runways, where exposed to the weather, are not satisfactory. For runways not subject to heavy concentrated wheel loads, and in climates where anti-freezing chemicals are used, bituminous material is satisfactory if there will not be an excessive amount of grease or oil dropping upon it. It is essential, however, that proper curbs be used to confine the material. Curbs can be constructed of concrete, treated wood, or old rail. For bituminous platforms a base of good crushed stone, at least 8 in. thick, and well rolled and drained, should be provided. This should then be topped with at least two inches of bituminous material, which should also be well rolled.

The committee believes that concrete is satisfactory for runways, just as it is for floors, and that in its construction the latest practice recommended for highway pavements should be followed. Some years ago it was considered good practice to pour a preliminary curb on each side of the runway of concrete and then fill between these curbs with the concrete pavement. The best practice now, if curbs are required, is to pour them integral with the slab.

Conclusion

In conclusion, your committee recommends that floors for shops and enginehouses, and runways, should be constructed of concrete, where possible. Concrete provides the best wearing surface, and while not easily patched, this can be done satisfactorily. In constructing these floors, particular care must be taken in the selection of the aggregates, limiting the water, proper tamping or compacting, and adequate curing. If all these details are taken care of, it is felt that one of the most satisfactory floors obtainable can be constructed.

We further recommend that runways and platforms be constructed of either bituminous or portland cement concrete —whichever is better suited to the climate and other special conditions involved.

DISCUSSION

M. Coburn (John D. Bolton Co.) opened the discussion by recommending the use of air-entrained concrete in all floors and runways. Chairman Gilmore stated that air-entraining had been considered but omitted from the report since it was not the consensus of the committee to include it.

Joseph M. Giles (M.P.) stated that he had just completed pouring 27,000 sq. ft. of concrete based on specifications similar to those for floors contained in the report, except that air-entrained concrete was used. The project included 3/5 mi. of 10-ft. runways poured in two courses—a 4-in. base covered with a 2-in. topping. Reinforcement consisting of 6

in. by 6-in. wire-mesh, was placed on top of the 4-in. slab immediately after pouring. Mr. Giles added that the construction was too recent to tell what results would be obtained, but felt that additional information would be available next year. The spacing of expansion joints was guided by the specifications for nearby highways and those recommended by the Portland Cement Association. The concrete was mixed and placed by company forces from mobile mixers mounted on cars, and surfacing was done by power floating machines.

Another speaker from the floor stated that, since air-entraining is comparatively new, it would take a few years before the results can be fully appraised. This speaker also expressed the opinion that all runways should be reinforced with some sort of temperature reinforcing and be of a single-course pour of 8 in. Chairman Gilmore offered the opinion that something should be done about the steel-wheel trucks so widely used in and around shops. Replying, one member stated that steel grids were used in runways on his road in some cases and had been successful in combatting the wearing effect of steel wheels. One of these installations has been in service for about 15 years.

Economies To Be Derived Through The Modernization of Obsolete Water Stations

Report of Committee

Howard E. Graham (chairman), asst. supt. w.s., I. C. Chicago; W. D. Gibson (vice-chairman), asst. engr., C.B.&Q., Chicago; H. D. Curie (vice-chairman), mast. carp., B.&O., Garrett, Ind.; John H. Babbitt, asst. div. engr., B.&O., Indianapolis, Ind.; R. E. Caudle, asst. engr. str., M.P., Houston, Tex.; G. S. Crites, div. engr., B.&O., Baltimore, Md.; V. E. Engman, ch. carp., C.M.St.P.&P., Savanna, Ill.; A. M. Glander, ch. carp., C.M.St.P.&P., Mason City, Iowa; J. P. Hanley, w.s. insp., I. C. Chicago; F. W. Hillman, asst. engr., m., C.&N.W., (retired), Chicago; Guy E. Martin, supt. w.s., I.C., Chicago; L. Summers, w.s. repair., M. P., Bismarck, Mo., and E. E. R. Tratman (retired), Wheaton, Ill.

THE conditions relative to water supply on the railroads have changed more drastically in recent years than most other phases of railway operation. The increase in the size of locomotives, higher boiler pressures, and larger locomotive tenders and auxiliary tenders have combined to bring about many changes and advancements in every phase of water supply. Rapid increases in the use of Diesel locomotives are introducing new conditions of water supply. And the supply of drinking water to trains, stations and shops must also meet the new standards adopted by the U. S. Public Health Service.

Many Advances

In the early days of railroading water requirements were limited and supplies were usually secured from streams, ponds or shallow wells without much consideration to the quality of the water. The pumping was often done manually or by horse power. As the railways continued to expand, more and better water supplies were required and more mechanical equipment was developed and used for pumping. In the evolution, the windmill, the stream and internal combustion engines of various types and models have been used, but these are being discarded progressively for more modern types of equipment. During the last 23 years electric-driven pumping units have continued to improve until this form of power is generally considered to be the most economical and efficient for water facilities, although at some locations there may be factors which require the continued use of steam or internal combustion engines. The selection of pumping equipment should include a careful analysis of costs and dependability.

The progressive changes that have occurred in the past may be expected to continue in the future in meeting the water requirements of modern railroads —requirements which amount to billions of gallons of water annually for locomotives, buildings, shops and other facilities. This water should be adequate in volume and should be treated where

necessary to prevent scale, corrosion and foaming in boilers.

In connection with the urgent demands of wartime conditions during the last five years, the railroads made pronounced improvements in their water facilities. Tanks, pumping equipment, treating plants and pipe lines have been renewed or reconditioned to supply more water of generally better quality. This program should be continued where necessary and permissible. In addition to actual reconditioning work, the relocation and possible elimination of some existing water stations should be considered, as the increased use of Diesel locomotives will also affect the number and spacing of future stops for water.

Source of Supply

The source of supply is an important part of every water station. Some of the older intakes and suction lines which remain may require considerable reconditioning work. This work should be planned carefully and modern intake pumps, with necessary screens and silt-removing equipment should be used to replace obsolete facilities. The latter often consisted of timber cribs or open pipe lines laid into the water without protection from floating ice or debris. Many streams have become polluted with industrial and other waste material, with the result that these sources of supply have thereby become less satisfactory. In cases of stream pollution, a railroad may sometimes continue to use the stream until operating conditions become almost intolerable, before another source is planned. However, under such conditions, municipal supplies should be considered if the water is suitable in quality and quantity and the cost is reasonable.

In like manner the use of a well supply should be investigated. In many places, the water from deep wells has been found to be of better quality than that from surface supplies or shallow wells, and can be treated at lower cost. In fact, in some cases treatment can be eliminated entirely. Well water, as a rule, is colorless, without suspended matter, and is not subject to many of the troubles found in stream supplies. A case is known where a railroad was forced to abandon an unsatisfactory stream supply, and in securing a good city well supply it reduced attendance, maintenance and operating expenses. This also permitted the retirement of a steam pumping plant which was obsolete and deteriorated, and generally undependable in operation.

This same railroad has had very satisfactory results in several instances in the installation of wells to replace stream supplies. In these cases the well water has been superior in quality to the stream supplies that were abandoned, and by using automatically-controlled electric pumps on the wells a decided reduction was made in the operating expenses of the stations. The U. S. Department of the Interior has made extensive studies of the underground water supplies in many localities and their findings are often useful in determining the possibilities of obtaining suitable wells.

Reservoir sources of supply usually give less intake trouble than stream supplies. Where reservoirs are used, the dams should be kept clear of growing timber, spillways should be well maintained, and silting and vegetation should be removed to a reasonable extent. Such maintenance will prolong the maximum capacity of a reservoir and is desirable as a modernization program.

Power Units

Where municipal supplies cannot be used to advantage, the railroad must develop its own plants. Where this is done the selection of the power unit should receive careful consideration. While many primitive types of power were used in the earlier days, they have in most cases been replaced with either the steam engine, internal combustion engine, or the electric motor. The steam engine started to give way to the oil engine about 30 years ago and now both steam and oil units are being superseded by the electric motor.

There are many steam and oil-operated plants still in service that can be adapted for electric pumping, with the resultant economy which this method affords. New installations should be of automatic-electric equipment wherever possible. The steam plants still in existence have relatively high attendance, maintenance and operating costs. Coal is often unloaded from the main track or siding, requiring the use of section men. The equipment does not lend itself to automatic control and one or more pumpers are required for operation. The plant equipment requires relatively large housing, which, under present shortages of building materials and high labor costs, makes construction and maintenance slow and expensive. While the cost of coal still compares

favorably with that of electric power for similar amounts of work, the incidental operating and maintenance costs of the steam plant are usually much higher than for complete electric operation.

The internal combustion engines used in water pumping stations are, for the most part, of the so-called semi-Diesel type. Objections to these are somewhat similar to those found with the steam engine, namely, high installation, maintenance and operating costs. Automatic control has been used to some extent with modern internal combustion engines, but is not comparable to that found in the electric motor.

The former objections to the use of electric power units have now practically disappeared. Dependable power at reasonable cost exists in nearly all regions and installation, operating and maintenance costs are lower. Therefore, wherever economies can be effected, the railroads should adopt the use of electric pumps for new stations and also to replace existing steam and oil engine units.

For deep-well or surface supplies, the motor-driven centrifugal pump makes a compact pumping unit and is readily adaptable to automatic control. Furthermore, smaller buildings and pipe lines are required than for steam and oil units of similar daily capacity. The increases in cost for attendants, in many cases, make automatic operation of pumping stations very profitable. One railroad is known to have two operating divisions without a pumper and has made changes in equipment in the past five years that have resulted in a decrease in cost for pump attendants in excess of $100,000 anually. For these reasons the electrification of water facilities has become one of the principal items of water station modernization, and this practice should be continued.

Lime—Soda Ash Plants

Many lime and soda ash treating plants are becoming obsolete and can be modernized to advantage. The use of such plants on the railroads began about 1902. The early plants were known as the intermittent type, where the chemicals were added to the water in calculated amounts sufficient to treat one tank or other unit of water. The water was allowed to remain undistributed until the reaction was completed, after which it was pumped into the roadside tank, and the cycle repeated.

The intermittent-type softener was superseded by the continuous type, in which the chemicals are applied to the incoming raw water by proportioning equipment, and the treating tank capacity is large enough to permit the pumping of the raw water, the softening of the water, and the transfer of the softened water as one continuous operation. The waiting period between the cycles of softened water is eliminated, with resultant increase in the plant capacity. But the continuous-type plant is now being superseded by the suspended-sludge type plant. This latter type greatly reduces the reaction time required to soften the water and thereby increases the plant capacity, with a relative decrease in the size of the reaction tank and the housing and ground space required.

One railroad reports a location where an intermittent plant was erected in 1904, was converted into a continuous plant in 1917, and was then rebuilt as a suspended-sludge type plant in 1946. The latest plant occupies less ground space, which is very limited at the location, and has a reaction tank of 50,000 gal. compared with 150,000 gal. in the former plants. Notwithstanding this, the softened water production is 36,000 gal. per hr. compared with 25,000 gal. and 15,000 gal., respectively, for the continuous and intermittent plants. The present plant has automatic electric control, and the water levels are maintained in roadside tanks, filter tanks and a soft water cistern by means of float valves and float switches.

Other railroads report effective and economical results from the suspended-sludge type treating plant. When intermittent or continuous plants are due for reconditioning or rebuilding, this type of plant should be considered as modern procedure.

Internal Treating Plants

One of the most effective methods of improving the quality of railroad water supplies in recent years has been the development and wide application of the internal, or wayside, method of treatment. This method, which is adaptable where scale conditions are not excessive and where the construction, maintenance and operating costs of lime and soda ash treating plants are not justified, has been improved during the last ten years to the extent that scaling, pitting and foaming conditions in steam boilers can be corrected or greatly reduced.

The use of commercial soda ash, com-

bined with proprietary compounds, reduces the cost of the treatment to a reasonable basis. Improvements have been made in the proportioning equipment to apply the chemicals in definite amounts to the water to be treated, and the control chemists of the railroads check the water regularly to insure that the proper treatment is being maintained. Under these conditions, internal treatment is effecting decided economies in boiler maintenance, and its use should be considered where untreated water conditions are not satisfactory.

Water Service Mains

The water mains used by railroads are, for the most part, made of cast iron, which is a durable material, and which presents no unusual difficulties due to deterioration, except in a relatively few locations where the soil or the water will cause corrosion. However, there are many locations where incrustation, internal deposits, and the formation of air pockets may seriously affect the carrying capacity of the water mains, resulting in increased pumping costs.

Air relief valves should be used at summits, and blow-off valves in the valleys of water lines laid through rolling country. Considerable economies can be made by cleaning pipe lines where excessive friction loss is caused by incrustation, tuberculation, organic growth, or deposition of sediment.

In cleaning pipes, cases are known where partly closed valves, projecting joint material and other unsuspected obstructions have been located and removed. The reduced carrying capacity of a water main can be very serious and usually is not discovered until a partial failure of the water supply occurs. Consideration should be given to investigating the friction head loss in pipe lines, especially the older lines, to determine the actual monetary loss.

The greatly increased demand for water for locomotives in recent years has taxed pipe lines to the limit of their capacity. Additional material for larger mains is difficult to secure. By cleaning existing mains, their original capacity can be restored. The cost of cleaning mains four inches and upward in diameter with modern pipe-cleaning methods is much less than installing additional mains or replacing incrusted lines with new pipe.

Wells and Pumping Equipment

A considerable proportion of railroad water is secured from drilled wells, which vary from 50 ft. to several hundred feet in depth. A well supply is the only available source in some locations while in other locations wells provide water of better quality than can be had from streams or surface supplies, and the water can be produced more economically.

The earlier deep-well installations were equipped with vertical displacement pumps of the single or double-acting type, operated by steam, gasoline or oil-engine power. The single-acting steamhead pump is an example of this kind of well equipment and was used to a greater extent than the other types. In recent years the electric motor-operated turbine pump has superseded many of the former pumps, and in locations where the older equipment is still used this type of equipment should be considered as modern practice.

The electric-driven motor turbine pump lends itself readily to automatic control; thus, attendance and operating costs are reduced. Pump houses may be relatively smaller, and in non-freezing locations the pumping unit is often protected only by a metal fence enclosure, instead of a house, with a resulting decrease in installation and maintenance expense as compared with the older types of equipment.

The production of water from drilled wells often decreases after several years of use, due to incrustation in the well screen or in the water-bearing formation. Several modern methods are now in use to restore or improve the production, including the use of acid, dry ice, air pressure and mechanical cleaning, singly, or in combination.

The acid method is the most effective if a chemical analysis of the water or scale indicates that acid will dissolve the deposit. The acid usually used is 15 per cent hydrochloric, with suitable inhibitors to prevent damage to the equipment. The acid treatment of wells may now be secured on a contract basis from companies specializing in this work. In such cases the acid may be delivered to the well site in trucks and pumped into the well by the contractor's equipment.

The acid treatment is not effective in packed sand formations or where silt has accumulated in the well. In such cases, mechanical cleaning, surging, air pressure and bailing should be used to remove the obstruction and dislodged material from the well. Where well production has decreased, it is economical to restore the yield by suitable methods.

Raising the pumping water level will result in savings in both power and maintenance costs.

Cathodic Protection

Several railroads report the use of the cathodic method to prevent corrosion in the interiors of steel water tanks below the water line. This method, in many cases, is more economical than painting. When tanks are painted, considerable out-of-service time occurs while the interiors are cleaned, painted, and dried. This out-of-service time is expensive, and causes inconvenience when other means of providing water are necessary.

The cathodic method operates while the tank is in use, and out-of-service time is thus eliminated. This method is based on the passing of a low-voltage electric current from an anode suspended in the water in the tank, through the water, to the tank shell—the current being applied so as to make the steel shell electro-negative.

The principle of operation in the cathodic method of protection is as follows: The current flows from the anode to the cathode, dissociating hydrogen ions by electrolysis of the water. The tank shell, being electro-negative, attracts the positive hydrogen ions, which form a protective film on the interior of the tank below the water line. That portion of the tank above the water line must be protected in the usual manner by paint or other material. While this system of tank protection is of comparatively recent development, it is being used successfully and economically by a number of roads.

Conclusions

As outlined in this report, there are many obsolete water stations and component parts of stations that could be modernized to economic advantage. However, extensive modernization should be considered in the light of the decreased water consumption of Diesel locomotives, and the rapidly increasing number of such locomotives. At the present time some railroads are Dieselized to the extent of 50 per cent or more. This change in motive power will permit the retirement of many water stations and a change in the design of others. Likewise, the distance between water stations has increased from 25 mi. to 50 mi. and more due to the increased water capacity of present day steam locomotive tenders. It appears that water stations for Diesel locomotives may be 200 mi. or more apart, or at division points.

Some intermediate water stations should be retained as reserve facilities, or as alternate points for water stops, to suit traffic conditions, and the stations so retained should be suitably modernized. Water stations for serving Diesel equipment will differ in some respects from stations now serving steam motive power. The large water columns and column supply mains now used to fill steam locomotive tenders will not be required.

Delivery of Diesel water can be made through smaller mains having several 2½-in. to 3-in. connections. These can furnish water at a rate of 300 to 400 gal. per min. to each unit at the same time. Under these conditions, higher pressures and booster pumps may be needed to modernize the water facilities for Diesel equipment. It may be necessary also to treat the water for Diesels by one of the demineralization processes in order to secure a water of the desired purity for the successful operation of the Diesel equipment.

Supplying water for modern locomotives, as well as for drinking purposes on cars, requires considerable study and planning to provide suitable quality and treatment control.

DISCUSSION

Referring to that portion of the report dealing with cathodic protection, a member raised the question as to what effect variations in the amount of water in the tank would have on such protection. Chairman Graham answered this by saying he was of the opinion that variations of three or four feet in the water level would not have an adverse effect if the unpainted areas were exposed for only a few days, but felt that painting should extend a few feet below high-water line as a safety measure. Another member expressed the opinion that such protection could be provided without interruption to service and without draining the tank entirely. E. B. Tourtellotte (B. & M.) inquired whether there are locations where cathodic protection has not been successful. According to Mr. Graham there are locations where the process has failed but these failures, he said, were due to lack of maintenance.

Next there was a query from a member as to whether the responsibility of maintaining cathodic protection systems rests

with the water service forces or the electrical forces. Mr. Tourtellotte advised that inspections were made monthly on his road by an electrician, which included a report on the amount of water in the tank at that time, and that the replacing of the anodes was the responsibility of the electrician. One member suggested that electricians should do the actual work of maintaining the cathodic equipment under the supervision ofthe water service department.

Answering an inquiry regarding the effect that Dieselization of locomotive power has had on water supply and the number of stations required, Mr. Tourtellotte said that his road had been able to retire seven water stations due to Dieselization and that such stations now average 50 mi. apart. He also said that the cleaning of water mains during the war years had resulted in an increase in the flow of water through these lines of 55 to 63 per cent.

Utilization of New Types of Material in Buildings

Report of Committee

B. M. Stephens (chairman), arch. engr., T. & N. O., Houston, Texas; Henry G. Johnson (vice-chairman), asst. engr., C. M. St. P. & P., Ottumwa, Iowa; L. C. Winkelhaus (vice-chairman), arch. engr., C. & N. W., Chicago; K. W. Charlson, v.p. and ch. engr., Cunningham-Rudy Company, Detroit, Mich.; E. T. Cross, v.p., Armco Drainage and Metal Products, Inc., Middletown, Ohio; M. H. Dick, managing editor, **Railway Engineering & Maintenance**, Chicago; A. G. Dorland, asst. engr., E. J. & E., Joliet Ill.; W. T. League mast. carp., Penna., Toledo, Ohio; W. G. Mateer, pur. agt., E. J. & E., Chicago; W. V. Parker, research engr., U.S.P.H., Serv., Memphis, Tenn.; S. R. Thurman, b. & b. supvr., M. P., Nevada. Mo.; E. R. Wolf, sales engr., Marine Engineering & Supply Co., Los Angeles, Cal., and O. F. Womeldorf, div. engr. (retired), C. & N. W., Norfolk, Neb.

GENERALLY speaking, there are relatively few building material items presently available for extensive and economic use which can properly be classed as distinctly new types of materials. Insofar as railroad building construction and maintenance is concerned, however, there are a number of materials which can be called new types because they have not heretofore been generally used.

The subject matter of this report should not be considered as completely covering the entire field of recent developments, effort having been made to limit the scope of the report to only such items as appear to possess qualities making them desirable for use by the railroads. Ten general classifications of new types of materials have been considered.

Glass Products

Problems of providing maximum light transmission and over-all pleasing appearance are being solved successfully and economically by the use of corrugated glass sheets, either of wire glass or plain glass, and by the use of glass blocks.

Corrugated wire glass is applicable for use as siding, side panels of saw-tooth type roof construction, enclosure material for elevator shafts and the like, and roofing in skylight, marquise and canopy construction. Plain corrugated glass may be used for interior partitions and decorative glass panels and can be either smooth finished or sand-blasted on one or both sides.

Sheets of corrugated glass can be applied directly to structural framework, can be made water-tight, and can be used readily in conjunction with corrugated metal, corrugated asbestos or other types of siding and roofing.

Where the simultaneous provision of light transmission and ventilation is not mandatory, structural glass blocks are particularly valuable for use in roundhouses, machine shops, etc. These blocks readily take the place of conventional windows and, when used in connection with construction of exterior walls, have the added advantage of substantially increasing light transmission without materially disturbing the heating factors of the building as a whole.

Glass blocks are available in several sizes and designs, the several designs being for the purpose of meeting various

problems and requirements of light transmission. From an architectural standpoint, glass blocks can be worked into attractive panel arrangements. Panels can include clear glass window sash when ventilation is required or small areas of visibility are desirable. Glass blocks are quite strong, but not load bearing, and are not subject to ordinary breakage. If broken, they are easily replaceable. Panels are readily cleansed by wetting, brushing and washing down with a hose.

Structural Glass

Structural glass exterior and interior finish is rapidly gaining in favor among designers. There are two types of this kind of glass; sheets of polished homogeneous material, and precast, load-bearing concrete blocks faced under pressure with polished structural glass. These products provide the designer with a means of achieving extremely attractive decorative effects, both exterior and interior, without sacrifice of economy. They are durable, not easily damaged, and are readily maintained and cleansed. The homogeneous sheets are quite suitable for dado and wainscot purposes and prefabricated sheets can be used for partitions and inside wall finish.

For construction requiring special treatment because of heating or air-conditioning, insulating glass units can be used satisfactorily. These units are formed by sealing dehydrated air between two or more panes of window or plate glass. The framework for these units must be of rigid design to prevent damage to them. Resistance of the units to the transmission of heat is high.

Heat-Absorbing Glass

Heat-absorbing glass is rapidly coming into general use in various types of shop buildings, storehouses, and other buildings. This is a blue-green colored glass that absorbs most of the sun's heat rays, admits an adequate amount of light, and substantially reduces glare and eye-strain. It is available in thicknesses of ⅛ in. and ¼ in. Ordinary glass ⅛ in. thick transmits about 87 per cent heat, while the same thickness of heat-absorbing glass transmits only 34 per cent; similarly, 1/4 in. thick ordinary glass transmits 83 per cent heat, while the same thickness of heat-absorbing glass transmits 21 per cent. Heat from the sun is absorbed by this type of glass, thus raising the temperature of the glass until the point is reached where re-radiation equals the heat supplied by the sun. The absorbed heat is re-radiated from both surfaces of the glass, and it is assumed that one half goes to the outside and the other half to the inside.

Sun Screens

Although not a glass product, mention should be made here, apropos light and ventilation, of a relatively new window screening. This material was developed to provide a shading device, permitting passage of light and ventilation and at the same time protect against the direct radiant heat from the sun.

This sun screen, built on the principle of the venetian blind, makes it possible to achieve 80 to 90 per cent of effective radiant-heat window insulation with practically no interference to ventilation, light or view. Louvres, of minute width bronze, 17 to the inch, are set at a fixed angle determined to give maximum efficiency with minimum interference to view and light. The sun screen is installed in same manner as conventional window screening. Its use is particularly indicated in conjunction with air-conditioning installations.

Paint Products

Silicone resin paints have entered the field of heat-resisting and moisture-resisting materials. Some blends of the material will withstand continuous exposure to temperatures as high as 500 deg. F. and are ideal for such applications as ovens, smokestacks, exhaust manifolds, radiators and the like. Other blends of silicone resin paints are highly satisfactory for heat and moisture-resistant insulations for electric motors, high and low-temperature greases, heat-stable fluids and anti-foam compounds.

Water-base cement-binder paints have come to the forefront in the painting of masonry where conditions are such that oil-base paints cannot be successfully applied and where it is considered desirable to repaint every three or four years. These paints are normally furnished in powder form, to which water is added immediately prior to use.

As a rule, the ingredients of water-base cement-binder paints are more or less the same, and all of the many brands available will produce about the same results. An attractive decorative coating with three or four year's life can be se-

cured on brick, stucco, concrete or tile walls by use of these paints. Many claims have been made with respect to the waterproofing qualities of these materials, but in most instances such claims are somewhat exaggerated and the materials will not stand up very well in most areas when used under abnormal conditions.

Oil-base cement-binder paints are actually normal oil paints with portland cement added. Such paints have been on the market for a number of years, but only recently have been used extensively. In normally dry climates of low humidity, oil-base cement-binder paints can be used successfully for the painting of masonry, provided the masonry has been properly sized with an alkali-proof sealer before painting.

Painting Masonry Walls

Masonry walls painted with oil-base cement-binder paints will not require repainting as often as when water-base type paints are used. These products have about the same waterproofing qualities as water-base products. One prominent characteristic of the oil-base product is that it can be applied with lasting and satisfactory results directly to new galvanized metal without the necessity of allowing the metal to weather or of applying a special under-coater.

There have been some recent developments in fire-resistive coatings, although insufficient test data is presently at hand upon which to base recommendations for their use. Oil-base cement-binder paints have some value as fire-resistive coatings, particularly when the final coat is sanded. Several other special products recently placed on the market appear to have characteristics which tend to resist fire exposure.

Considerable progress has been made in the development of rust-inhibitors for use on metal structures. While most of these products were available before the War, there has been a decided improvement in their characteristics. These materials, of which there are a number equal in quality, can very often be used to good advantage.

Plastic Coating

While not exactly a paint, a war-born plastic paint-like product is now ready for general distribution. This product is a brushless plastic finish for applying to furniture, walls, floors, cabinets, wood trim, linoleum, etc. The material is wiped on with a cloth, touch dries in ten minutes and dries hard in six hours. No conclusive test data is yet available as to its lasting qualities or economy.

Closely associated with the subject of paint and painting is the recent development of a special pre-treatment for galvanized steel sheets. This pre-treating process forms a phosphate film on zinc surfaces, making it possible to apply paint to zinc-coated materials successfully without having to make allowance for a suitable weathering period.

Pre-Cast Concrete Products

Concrete blocks are being used extensively as substitutes for brick and hollow tile and in lieu of poured-concrete construction. Their properties permit savings in steel and formwork and afford economies in heating. The blocks have a high sound insulation value and are easy of installation and later removal, if desired.

There are two types of blocks; those similar in design to hollow tile, requiring mortar joints, and those with interlocking edges. The interlocking type is laid up without mortar joints, rigidity of the wall being achieved by filling the interstices of the blocks with concrete at regularly spaced intervals.

Leakage through walls, due to porosity of the blocks, generally requires the application of some type of waterproofing agents to the finished exterior wall surfaces.

Pre-cast concrete roof slabs and beams of various types and designs have been on the market for a number of years but have only recently come into general usage. For permanent and fire-safe construction, use of these items may well be indicated, particularly for large projects where sizes can be made more or less standard.

Wash fountains and shower stalls of precast concrete are in wide use in industrial wash and shower-room areas where a great many people have need for washing facilities at about the same time. These items are economical, durable, easy to keep clean and presentable, and are not difficult of installation.

Many large industries have successfully located central pre-casting plants for small concrete buildings. Forms are used over and over and pouring of the concrete is carried on under rigid control, thereby insuring soundness of construction. When small buildings, such as

watchmen's huts, telephone booths, etc., are needed, they can be promptly shipped to the location required and erected quickly without the services of skilled labor, a feature that is becoming increasingly important.

Cement-Asbestos Products

Corrugated sheets of cement-asbestos are suitable replacements for corrugated metal and can be satisfactorily used for most types of railroad building construction requiring corrugated metal. Some of their advantages are high resistance to weather and temperature variations, ease and speed of construction, and noncombustibility. Flat sheets of cement-asbestos have substantially the same characteristics as corrugated sheets, although they have much less strength than such sheets.

Rigid asbestos shingles for building work are coming into wide use, both for roofing and for siding, there being a great variety of such shingles available. Use of shingles is indicated for remodeling the exteriors of frame buildings and for the replacement of wood shingles on roofs. Very attractive results can be obtained by the proper and considered application of shingles of this type.

Cement-Asbestos Lumber

Recent development in the use of cement-asbestos lumber seem to indicate solution of the problem of providing a movable and salvable partition wall, and at the same time of achieving an appearance of stability and permanence. Partition units are formed by the use of standard studding to which the cement-asbestos lumber is attached by special fastenings. The studding in the wall units is not attached to the floor or ceiling, special floor and ceiling channels being used for the purpose of maintaining the units in place.

In addition to being almost 100 per cent salvable, the wall units have the advantages of providing an easily maintained surface, good resistance against the passage of sound, resistance against fire exposure, and a surface free of projections. Their use is indicated where space requirements in offices and similar places are subject to rapid changes.

Impregnated cement-asbestos sheets are indicated for use where especially high resistance to moisture, chemical fumes and gases is desired. Both surfaces of the sheets are treated with a bituminous compound, which acts as a seal against attack by destructive agents.

Structural Aluminum Products

Increased use of structural aluminum products is the result of efforts by designers to reduce weight of construction without impairment of strength, to achieve improvement in resistance to corrosion, and to present a pleasing architectural appearance. The aluminum used in the manufacture of structural shapes, etc., is in the form of alloys of various characteristics. In selecting aluminum products for use, therefore, consideration must be given to the purpose for which the aluminum is to be used.

Alloys are produced in many forms by drawing, extruding, rolling and forging. Structural shapes, such as angles, beams, tees and channels, and plates of relatively large size, are available. Also available are special architectural shapes, such as hand-rails, pilasters, mouldings, cornices and fascia, coping, thresholds, etc.

Aluminum sheet is also manufactured for use as roofing and siding. Roofing is made in the interlocking-shingle type, flat type with pre-formed joints, or corrugated-sheet type. Siding is available in flat or corrugated sheet, drop siding, or clapboard type. Some of the corrugated aluminum roofing and siding, however, is of too light a gage to be recommended for industrial use.

The committee suggests that where aluminum metal is contemplated for use in enginehouses, consideration be given to the report of Committee 13-Application of Corrosion-Resisting Materials to Railroad Electrical Construction, Association of American Railroads, Electrical Section, 1947 Reports.

After continued exposure, the bright natural finish of aluminum becomes somewhat dull. To overcome this dulling, a special finishing process has been developed, which augments the natural film of aluminum oxide, thereby protecting the metal against weathering, etc. In addition, the finish permits the adding of color if desired.

Floor Finishes

Flexible floor coverings in general use at present include cork tile and sheet, asphalt tile, rubber tile, and linoleum, all of which have several disadvantages along with their several advantages. A new type of flexible floor covering made

from both plasticized and unplasticized vinyl resin is becoming available in the form of floor tile or rolled floor sheet. Vinyl-resin floor coverings have all the advantages of other types of flexible coverings, with the added advantages of high strength, durability and resistance to attacks by greases, acids, alkalis, etc. The coverings can be furnished in a wide range of colors and their maintenance is especially easy due to their smooth finish and resistance to greases and other such agents.

In the maintenance of concrete floors and, in some instances, wood floors, use of one of several asphaltic-mastic type of floor resurfacers may be indicated. These products, sold under various tradenames, are more or less similar in characteristics and performance. They are useful in cases where concrete floors have become badly worn, pitted or broken and patch repairs are considered advisable instead of overall floor replacement. The material sets up to a fairly hard finish, is not difficult to place, and will stand a great deal of hard usage.

Admixtures

Several types of concrete admixtures have been developed in recent years for use in new concrete floor construction. These admixtures are for the purpose of securing durable, impervious and non-dusting surfaces for concrete floors subject to heavy traffic. Good resistance to attacks by destructive agents is also secured by use of certain types of admixtures.

A new type of steel floor plate appears to have excellent possibilities for floor work, These plates are 12 in. square, flanged down on all four sides, and have many teeth-like anchors stamped from the wearing surface to provide bond to the concrete. Use of these plates is particularly desirable where floors are subjected to heavy and sustained travel.

Interior Wall Finishes

Enameled steel tile is available in baked enamel and porcelain enamel finish and a variety of colors. The baked enamel finish can be marred by contact with sharp objects. The porcelain enamel finish will resist harsh treatment and its surface will not graze or crack. The tile is particularly useful for corridors, washrooms and toilets, dining rooms, and similar areas.

Cloth-back wood veneer in 40 odd types is being successfully used for decorative purposes where an appearance of luxury and distinctive wall treatment is desired. The product is genuine paper-thin wood veneer glued under heat and pressure to cotton sheeting with water-resistant adhesive. The sheets can be hung to provide almost any design pattern desired.

Cloth-backed glass is very similar to cloth-backed wood veneer and can be used in much the same manner as the wood veneer. Thin sheets of glass are bonded to fabric backing and are then cut into small squares or rectangles. The material is available in 25 or more colors and 4 types—opaques, flat mirror, rolled pattern mirror, and metallic. Corners with a minimum radius of 5 in. may be turned without difficulty. The product is resistant to every surface attack to which sheet glass is resistant.

Sheet plastic on plywood provides a finishing material readily adaptable for many interior uses. The product is formed by fusing liquid plastic to plywood by heat treatment. The surface of the material is hard, smooth and polished and is easily maintained. The material should not be used in locations where it will be subjected to abnormal abuse and attacks by vandals.

Glazed-surface wood veneer sheets are substantially the same as sheet plastic on plywood and, therefore, are suitable for the same purposes. The glazed surface sheets are not so durable as the plastic sheets, but they can be used to good advantage in numerous locations where they are not subject to abuse other than normal cleansing operations.

Although fibre or composition ceiling blocks and wallboard panels and planks have been available for some years, use of these materials for interior re-decoration and modernization has not been general until recently. These products lend themselves readily to interior refinishing work at relatively low costs. Ceiling blocks, both acoustic and non-acoustic, present excellent means for refinishing ceilings. Attractive wall treatment can be achieved by use of wallboard panels or planks.

Metal Buildings

War demands developed considerable usage of pre-fabricated metal buildings. Buildings of many sizes and several types of pre-fabrication are available and have proved to be relatively economical and entirely satisfactory.Among

their chief advantages are rapidity and ease of construction and adaptability to ready removal from place to place without loss of any part except foundation.

These buildings are generally either of the frameless type, in which the flanged panels are the load-carrying members, or the light steel framing type, in which the framework is covered with lightweight metal sheets. All parts of the buildings are metal, although wood sash and doors can be used if desired. Various combinations of floor plan can be achieved without difficulty and the overall appearance is not unpleasing.

Metal Roofing

Pre-fabricated steel roof decks of a number of types are now being used to good advantage under normal conditions. These decks can be substituted readily for pre-cast concrete and gypsum and usual wood decks and have the advantage of holding the roof framing costs to the minimum. One relatively new type of metal deck consists essentially of flanged interlocking steel panels with the flanges turned down. Insulating board and built-up roofing can easily be applied over metal decks.

Around terminals and other locations where corrosion and abrasion must be considered, asbestos-bonded steel sheets have particular usefulness. These sheets are made of steel or iron, coated with zinc in which asbestos fibres are imbedded while the zinc is molten. Final treatment consists of an application of a bituminous saturant under pressure.

Pre-Cast Gypsum Products

One pre-cast gypsum product—sheet-rock—has long been in use for interior partition work. Out of sheet-rock has been developed solid partition units and gypsum roof plank, which are merely sheets of sheet-rock glued together under heat and pressure.

Partition units are available in tongue-and-groove type or shiplap type, in thicknesses of 1 in. and 1½ in. These units are particularly useful for non-load-bearing partitions and where height and length of partitions are not excessive. Wood bucks and top and bottom plates laid flat against the panels add considerable strength and result in a pleasing appearance.

Gypsum roof units are two-ply, three-ply or four-ply, with the sheets in the plies being placed off-center to form shiplap edges. Thicknesses are 1 in., 1-1/2 in. and 2 in. and the units are treated with a water-resistant coating after the sheets have been glued together. The units will carry almost the same superimposed roof load as wood sheathing of comparable thickness, and are adequate replacements for wood as the decking for built-up roofs. They afford the added advantages of speed and economy in placing, due to their large size, and the further advantage of being rot-proof and vermin-proof.

Conclusion

The necessity for brevity in this report has made it impossible to do more than touch briefly on the many new building material items which can well be used in various types of railroad work. Conspicuous by their absence are remarks apropos to the many new developments in the heating, ventilating and lighting fields. There have been numerous new items and advances in these fields in the last few years, most of which are worthy of consideration for use in railway freight and passenger stations, shops, enginehouses, office buildings, service buildings and all types of roadway structures.

As partial basis for the substance of this report, reference was made to the report of the Building Committee of the American Railway Engineering Association, published by the association in Bulletin 463 of December 1946. Readers hereof desiring more detailed information about many of the products mentioned are referred to this A.R.E.A. committee report.

DISCUSSION

J. J. Healy (B. & M.) opened the discussion by saying that he had been engaged in replacing steel sash in enginehouses with glass block, using company forces, and that the average output was 80 blocks per day per man as compared with 100 by nearby contractors' forces. On this job, he said, ventilation was being obtained by installing wood louvres in the upper portions of the block enclosures, covered on the inside by plywood covers operated from the floor level. These have been very successful, he stated.

R. W. Gilmore (B. & O.) expressed the opinion that, in order to obtain an output of 80 blocks per day, a wide area would

have to be worked, since the slow drying of the mortar prevents the placing of more than three courses of blocks per day in the same panel.

J. L. Dougherty (W. M.) stated that the use of imitation brick siding for roadway buildings had advantages and presented a neat appearance. Another member added that such siding also provides some insulation, results in reduced maintenance, and is economical to apply.

E. B. Tourtellotte (B. & M.), in commenting on thermo-pane glass, brought out the fact that, in the northern part of the country, the falling of snow on such glass presents a problem because the snow does not melt as it does on other types of glass.

Recent Tests on Determination of Impact and Stresses in Steel, Masonry and Timber Bridges

By E. J. RUBLE

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THE present high-speed freight and passenger traffic carried by the railroads of the United States is, to a large extent, powered by Diesel or new steam locomotives that have been designed for high speeds, or by old locomotives revamped to attain these speeds. About 15 years ago, when the trend for all motive power turned definitely upward, the bridge engineers began to consider the effect of the heavier and higher speed locomotives on their bridges by first making an analytical study and later by field, tests to insure that the bridges were of adequate strength to meet the new demands that were imposed upon them.

The effect on a steel, timber or concrete structure during the passage of a locomotive is to produce a lengthening or shortening of the various members composing the structure and the term "strain" is used to denote this change in length. The unit stress in the member is determined from the amount of strain and the known physical properties of the material. As an example, during the passage of a locomotive over a girder bridge, the lower flange is lengthened, which is a tensile stress while the top flange is shortened, which is a compressive stress.

A structural material, such as steel, is perfectly elastic within certain limits and if a known load is placed on a square inch of steel, the steel will strain or stretch a definite amount. If the load is released the steel will return to its original position. The relation between the strain and load is definitely known so that if the amount of strain is measured, the load and the unit stress can be accurately determined.

The strains in the steel, timber or concrete bridge members resulting from a locomotive, of known axle weights, standing or moving very slowly over a bridge, can be calculated with a fair degree of accuracy but when the speed of the locomotive increases, the strains also increase and this increase in strain cannot be determined analytically. The increases in strain, over that produced by a slowly moving locomotive, is termed total impact and will vary with the different classes of power, the different lengths and types of bridges as well as the speed of locomotive.

The total impact effect results from several individual effects; such as roll effect, speed effect, track effect and hammer blow effect. Each individual impact effect becomes a maximum at a critical speed for a particular bridge. The critical speed for the roll effect is not necessarily the critical speed for hammer blow effect; hence, the maximum total impact is usually not a summary of the maximum individual effects but is a summary of the individual effects that occurred at one locomotive speed.

The "roll effect" results from the locomotive rolling from side to side, which increases the wheel loads on one side of the locomotive with a corresponding decrease on the other side. This effect is caused by the spring borne weight of the locomotive oscillating about a horizontal axis. The oscillations of the sprung weight is caused by out-of-level track, track joints and soft spots in the track.

The "speed effect" is presumably the result of the centrifugal force developed by the locomotive in following the path of the deflected span and the increased weight on the span resulting from the downward acceleration of the spring borne weight of the locomotive. The "track effect" is due to the irregularities in the track surface or wheel treads, to the periodic effect of wheel loads coming or going off the span and to a battered rail joint close to the center of the span.

The "hammer blow effect" is one of the most important impact effects and results from the periodic disturbing forces of the resultant unbalanced weights in the driving wheels of the steam locomotives. In short-span bridges, where this force can be applied only once, the effect is due to the centrifugal force of the unbalanced weights on the driving wheels and increases with the square of the speed, but in longer spans, where this force can be applied several times, the centrifugal force is magnified by the spring action of the bridge and, hence, becomes quite large even though it does occur at a lower speed.

Many Tests Made

For a good many years the effect of a locomotive crossing a railroad bridge at various speeds has been of great interest to the bridge designer. Many tests have been made during the last hundred years from which the various impact formulas have been derived. These formulas are usually a mathematical expression of some curves lying well above and enclosing the maximum impact values obtained in the tests.

Several research engineers in the past have accounted analytically, at least in part, for some of the results obtained experimentally. The most complete tests were those made by the Committee on Impact of the A.R.E.A., under the direction of F. E. Turneaure, dean of the college of engineering, University of Wisconsin. The results of these tests were published in 1911 and were the origin of the impact formula which was used for many years.

In 1935 a report was published by the A.R.E.A. describing in detail tests made on the Big Four by J. B. Hunley, engineer of bridge and structures at that time. Mr. Tunley secured readings on 39 different spans under about 300 different locomotives. The result of these tests formed the basis for the A.R.E.A. impart formula, adopted in 1935 and still in use. The report is based upon deflection readings only and no effort was made to secure strain gage readings under moving loads.

The discussion and adoption of the present formula in 1935 brought forth the need for more research on the subject, especially on short beam and girder spans where the results obtained by strain gage readings are more reliable than those obtained by deflection readings. A program of tests was prepared by the Iron and Steel committee, the Masonry committee and the Timber committee and a Special Committee on Impact was formed, now existing as A.R.E.A. Committee 30, Impact and Bridge Stresses.

In 1940, the Association of American Railroads approved a request for funds to employ the necessary personnel and purchase the required electrical strain gages so that the tests could be conducted under the direction of G. M. Magee, research engineer of the A.A.R. I was engaged by Mr. Magee to take direct charge of the investigation. Since that time we have increased the staff as the volume of work warranted and as qualified men became available, so that at present we have two field parties measuring strains and a small office force analyzing the data and preparing reports.

Test Equipment

Careful study was given to the selection of the type of strain gage that would be most suitable. The electromagnetic type of measuring equipment with oscillograph recordings had received the benefit of several years of experience and progressive development so this type of equipment was selected.

The general principle of operation of the electro-magnetic strain gage is quite simple. The gage is fastened to steel in which it is desired to measure the strain. A change in strain of the steel produces a change in the electrical impedance of the electro-magnetic gage circuit, and this change in impedance actuates a galvanometer in the oscillograph, producing a continuous record of the amount of strain on a moving film or sensitized paper.

The gage is attached to the member

in which the strains are to be measured by two special screws which are seated in two drilled and tapped holes, the center of these holes being exactly two inches apart. As the steel is strained, the two holes move apart or come together. The strain in the steel or the movement of the two holes is very small but the equipment can detect movements as low as 1/150,000 of one inch. In addition to the measurements of these microscopic movements, the equipment is capable of recording these movements even though they should move back and forth at a rate of 1000 times per second.

The strain gage equipment now used by the Research Staff of the A.A.R. is set up so that the strains at 24 individual locations can be measured simultaneously. In this manner it is possible to determine how the structural member is acting at all these locations at one time as well as at any time during the passage of the train.

In addition to the photographic record of 24 simultaneous strains, timing lines and position markers are also shown on the film. A small synchronous motor controlled by an electrically actuated tuning fork automatically marks the film with the time intervals of 1/100 sec. The relative position of each locomotive wheel with respect to any point on the bridge is marked automatically on the film so that the speed of the locomotive having a known wheel base can readily be determined by the elapsed time between the first and last locomotive wheels passing over the particular point on the bridge.

The Committee on Impact considered that the tests on short span bridges, or spans of 20 to 30 ft. in length, should receive the first consideration of the research staff. Their reason for this selection was that there are approximately 36,000 short span railroad bridges in the United States and the strains had never been reliably measured in any of these bridges under high-speed trains.

Short Spans Tested

The strains in 7 short span bridges were measured during 1941, 1942 and 1943 and a final report was made on this subject in 1945. The bridges selected for these tests varied in length from 20 ft. to 34 ft., and readings were secured under 900 Diesel and steam locomotives crossing over the bridges at speeds varying from 5 m.p.h. up to 85 m.p.h. for the steam locomotives and 100 m.p.h. for the Diesels.

The general procedure in making these tests, after the instruments had all been calibrated and erected, was to secure records under the Diesel and steam locomotives at various speeds with a battered rail joint in one rail close to the center of the bridge. The battered rail joint was then replaced with a continuous rail and records were taken under the trains at approximately the same speeds. After the tests with the battered rail joint on two of the bridges were completed, additional tests were made with rubber fabric pads ½ in. thick before the battered joint was removed from the bridge. These pads were placed under the regular steel tie plates at every tie on the test span and for about 15 ties beyond each end of the span. After the tests with the battered rail joint on one bridge were completed, additional tests were made after the battered rail ends had been built up by welding and the rail ends welded together.

The results of these tests were of particular interest to railway bridge engineers generally for the following reasons:

(1) The static stresses in the short span bridges, under both Diesel and steam locomotives, were lower than those usually calculated indicating that as the span deflects, the axle loads are carried to the ends of the spans by the frame action of the locomotive. The static stresses recorded under Diesels are only about 60 percent as great as those recorded under modern steam locomotives, as the weight of the Diesels is spread over a greater length.

(2) The maximum stresses in the bridge resulting from the wheel striking the battered rail joint at the center of the span were attained at a speed of 20 to 30 m.p.h. and became smaller as the speed of the locomotive increased. At a speed of 100 m.p.h., the effect of the battered rail joint was negligible.

(3) The total impact percentages recorded with a battered rail joint at the center of the span are about the same under the Diesels as those recorded under the steam locomotives; however, even with this condition the maximum recorded stresses under the Diesels are only about 60 percent of those recorded under the steam locomotives

on account of the lower static stresses.

(4) The maximum recorded stresses under both the Diesels and steam locomotives resulting from all the individual effects were attained at a speed of about 50 m.p.h. It appears that at the higher speeds, the locomotive is across the bridge before the stress can become very large.

(5) The maximum total impact percentages resulting from all the simultaneous individual effects were only about 75 percent of the recorded static stresses. The allowance for impact in the present A.R.E.A. specification is over 100 percent, the exact percentage depending upon the length of span and the transverse spacing of the beams. The results of these tests have made it possible for the bridge engineers to reduce their impact allowance, thus saving a considerable amount of steel.

(6) The ½-in. rubber fabric pads used under the regular steel tie plates and placed on top of the regular bridge or track ties did not reduce the amount of impact in these tests.

(7) A welded rail joint at the center of the span can be considered, as far as the bridge stresses are concerned, the same as a continuous rail over the bridge.

Tests On Girder Spans

With the completion of the tests on short-span bridges, the Impact committee requested that we conduct tests on girder spans ranging in length from 50 ft. to 105 ft. During 1946 we were able to conduct tests on five girder spans varying in length from 40 ft. to 70 ft. in length and our field party is now in the field working on several more spans. In conducting the tests on girder spans, we are following the same general procedure as was used in conducting the tests on the beam spans. The data we have analyzed indicate that the impacts in the shorter girder spans is somewhat below the present A.R.E.A. design impact allowance.

A considerable number of truss spans in service today were built at the beginning of the century and were designed for light locomotives. The railroads are now operating locomotives whose weights are about 50 percent greater than the locomotives for which the bridges were designed. During the war we were asked by several of the railroads to conduct tests on these bridges to determine if the stresses resulting from the heavier locomotives were above the allowable Rating Rules Stresses. Arrangements were made with the A.A.R. whereby the research staff would conduct these tests with the individual railroad bearing the actual costs of the tests such as salaries of the test party and all incidental expenses pertaining to the tests.

So far, we have tested 17 of the older design bridges for the individual railroads. The results of these tests showed that several of the bridges were over-stressed and it became necessary for the railroad to re-new these bridges while in others it was found that the stresses were satisfactory as long as the motive power was operated at restricted speeds.

What Tests Revealed

The detailed analysis of the data secured on some of these bridges will be of interest to all the railroads and we have secured permission to make a report of these results. In general, the few tests on truss spans indicate the following:

(1) The strains in the top chords of through spans are greater than the calculated strains while those in the lower chord are smaller than those calculated. This appears to be due to the stringer action in taking part of the lower chord strain with a corresponding change in the effective depth of the truss. The opposite effect has been found in deck spans.

(2) The maximum total impact percentages resulting from all the simultaneous individual effects were greater in some members than the present A.R.E.A. Impact Allowance, while in other members the impact is lower. As previously mentioned, the present A.R.E.A. Impact allowance is based upon the central deflection which is a summary of the individual strains in all the members and the bridge engineers are now considering an upward revision of their allowance for impact in the design of truss spans.

(3) The maximum total impacts have been found at a relatively low speed. For example, in a 150-ft. truss span

the impacts under a modern steam locomotive are a maximum at about 25 m.p.h. and then decrease with a further increase in speed. This is due to the speed of the locomotive drivers synchronizing with the natural period of vibration of the span.

(4) The strains in the individual eyebars of any one member are not always equal. It has been found that in some members one or two of the bars were not taking any of the load, with a resulting overstress in the other bars of the member.

(5) The joints of pin-connected trusses are usually frozen and this introduces high bending stresses in the eye-bars at the joints. In some eyebars we have found zero stress on one edge with twice the average stress on the other edge.

(6) The eccentricity in some of the compression members has been found to be greater than we would normally expect and this eccentricity has been found to exist about both *axis* of the member.

(7) A structure supported on high viaduct columns is very elastic and the impacts in such a structure are lower than those in a structure supported on rigid bearings.

(8) Large bending stresses have been found in viaduct columns supporting trusses and subsequent detail inspections have shown that the column bases were not bearing uniformly on the concrete.

Concrete Structures

The actual impacts in masonry structures have never been reliably determined and all design impacts are based upon empirical rules. The Masonry committee of the A.R.E.A. has requested the Impact committee to secure data on various types of concrete structures and this work has now been started.

The strains in a large concrete pier supporting a 100-ft. and a 75-ft ballasted deck girder spans have recently been measured under locomotives at various speeds. This pier is about 50 ft. in height so gages were placed midway between the top and bottom gages. In this manner it will be possible to determine if there is any difference in the impact at the top of the pier and at the bottom. It is common design practice for some engineers to design their piers for full impact on the bearing material while others use only half impact or no impact. Tests of this type on piers should determine exactly how much impact reaches the supporting soil.

Tests are also being planned on several concrete pile trestles. In these tests we will determine not only the impact in the piles and slab but also the load carried by each concrete pile as well as the stresses in the concrete and reinforcing steel in the slab.

In the open deck girder spans the locomotive wheel loads on the rails are carried to the girders by means of the bridge ties. The rail acts as a continuous beam on elastic supports so that the analytical determination of the amount of wheel load carried by each tie becomes quite complicated. In this analysis it is assumed that the rail has full bearing on each tie and does not take into account the loose ties. The analysis of tests we have recently made on timber bridge ties indicates that some ties are taking very little of the load while other ties are taking more than their proportion. This partially accounts for the occurrance of broken ties on bridges of this type.

Fatigue Explained

It has been definitely proven by such research professors as H. F. Moore and W. M. Wilson of the University of University of Illinois that steel will sustain a known static load indefinitely but if this load is removed and then replaced a certain number of times the steel will fail. For example, a square inch of structural steel in a fabricated member will not fail under a single load of 60,000 lb. but it will fail under a load of 26,000 lb. repeated a sufficient number of times. This phenomena is called fatigue. The railroads are now beginning to have considerable trouble with their older bridges due to the fatigue of the steel.

The floorbeam hangers of through-truss spans are subject to many cycles of stress varying from near zero to a maximum and a considerable number of these members have failed during recent years. The cost of repairing such a member under traffic is quite high so the bridge engineers felt that the exact cause of these failures should be determined in order that steps could

be taken to prevent these failures in the older bridge as well as in the bridges now being designed. A cooperative investigation on floorbeam hangers is now under way between Purdue University, with Professor L. T. Wyly in charge, and the Association of American Railroads. It is planned to determine the strains in floor beam hangers under static and moving locomotives and then go into the laboratory and duplicate these strains on similar test members.

An interesting investigation on the concrete bearing pressures under a railroad bridge rocker slab was recently completed at the Northwestern Technological Institute. The bearing pressures were determined under an actual bridge rocker and it was found that these pressures were not uniform on the concrete, as is generally assumed. The pressure varied from about zero at the edge of the slab to a maximum value of five times the assumed average value at the center. Considerable more work is planned in an effort to secure a more uniform pressure.

Unfilled Needs in Power Machines and Power Tools for Bridge and Building Work

Report of Committee

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FROM his very beginning on this earth mankind has endeavored to lighten and make easy his toil by providing mechanical means of doing it. At first, for countless ages, applications were simple and improvements were of slow development, dictated solely to making the burden of work easier. As time rolled on the tempo of man's existence stepped up, with improvements coming over night, based not entirely on humanitarian needs, but on economic considerations as well; witness the necessity of accomplishing definite tasks in the face of a dwindling labor supply during the war just past, and now in the face of diminishing financial returns.

Disregarding economic conditions, which even in our day has forced the curtailment of mechanized operations so that more hand labor could be employed, as occurred during the depression years of 1932 and 1933, let us give expression to what practical bridge and building supervisors wish for to lighten, improve and bring about greater economies in their work.

Treated timbers and piling in many bridges and buildings are now of such age that they must be tested for soundness. Prodding suspected timber with a steel bar is out of the question; and means for quick and accurate testing should be developed. It is reported that a device has been originated by a member of the engineering staff of a western state college, in conjunction with a western power company, whereby a repairman, by turning a crank, screws a probe into a treated pole. The resistance encountered is measured, indicating the soundness of the pole.

Transportation—Communications

Getting men to and from the job by means of track cars is proving expensive to the railroads, tiresome and irksome to the men, and a potential source for accidents. In well-settled sections of the country, paved highways parallel and intersect our various railway lines, so that buses or trucks, capable of being driven over the reasonably rough ground met with on rights of way for short distances, can be developed from equipment now available on the market.

In large bridge jobs, especially where

considerable height or length is involved, a loud-speaker system would be of vast benefit, so that the foreman in charge could speak to any of his men, including the crane operators, regardless of where they are located. This would keep all on the job informed as to what was going on and would prove a tremendous factor in promoting increased safety.

Similar results could be obtained on a quieter scale by an electronic system of communication, in which all stations on a circuit could talk to or listen in on one another by means of a combination transmitting and receiving unit with speaker and microphone.

Application of a communicating or warning system to motor cars, whereby the occupants of such cars could be made aware of approaching trains, would be a long step ahead in promoting safety.

Off-track pile drivers, mounted on wheels with rubber tires or on caterpillar treads, are proving far more versatile and economical than the standard track drivers. There is the possibility of equipping these drivers with augers so they can be used to bore holes for setting in the piles. Also, if equipped with generators, they could operate a light-weight chain saw to cut the piling at the proper cut-offs.

Light Bridge Derricks

Various railroads and some commercial firms have pioneered in developing a small derrick, mounted on a push car, for the handling of heavy timbers and castings. These usually have a table operating in a full circle and are counterweighted. They are hand operated both for raising and lowering, as the load, for considerations of safety, must be under control at all times. With the addition of a small geared motor, with power furnished by a small electric generator set of the type that is standard equipment for bridge crews, the work would be speeded up and manual labor lightened.

General-Purpose Equipment

Equipment mounted on rubber tires or caterpillar treads, depending on the terrain over which it is to be used, can consist of a compressor with the front end equipped with a light boom (this to be of a collapsible type for quick lengthening and shortening), a lifter for carrying timber and placing it where desired, a boom and bucket for excavation, a bulldozer blade, a winch, and even a mower. This type of equipment could erect and finish small steel spans, completely erect pile and timber bridges, excavate for foundations, lay culvert pipe, and make the back-fill. Bulldozer equipment is invaluable in case of washouts.

Small Electric Tools

As most bridge and building crews are now equipped with electric generators, there seems to be a demand for electric-driven tools, such as a one-man hack saw for cutting drifts between piles and caps, and between stringers and caps; dies for cutting threads on bolts to fit the lengths required on the job; impact wrenches for tightening and removing nuts on ¾-in. and ⅞-in. bolts; and a riveting hammer for driving ¾-in. and ⅞-in. rivets.

Hydraulic jacks, because of their lightness and lifting power, are much preferred by bridge crews. Work with these jacks would be expedited considerably if a small high-pressure hose would be attached to them, leading from a small power-driven hydraulic pump that would raise the jacks at the same speed at which they are now lowered.

Girder carriages, with flanged wheels running on rails, are commonly used to roll in steel spans erected alongside structures to be replaced. When the new span or spans are in place, jacks must be placed to raise them in order to release the carriages, and then to lower them into place. Jacks built into or forming a part of the girder carriages could lower the loads into place as soon as they were correctly spotted.

A light-weight jack for pulling chord and line bolts is advocated by one supervisor who has developed a jack for pulling drifts, but who finds it too heavy for pulling chord bolts.

Water Supply

For pulling turbine pumps out of deep wells, hand-operated winches are still in use. With such winches the work is slow and a large crew is necessary, especially for very deep wells. The Milwaukee Road has built two types of pullers which have proved very satisfactory. One consists of a standard five-ton hoist made by a Seattle concern, with a very small cast-steel winch, weighing about 100 lb., mounted on the upper plate of a steel bracket. On a lower plate of the same bracket there is mounted a five-

horse-power, three-phase, reversible, induction motor, connected to the hoist with three "V" belts. This bracket frame with hoist and motor can be handled by two men and, when in use, is attached to one of the posts of the tower. One man can raise or lower the well equipment by merely pushing a button. This piece of apparatus can be transported on a passenger train and can be set up very quickly. It has been used to pull a turbine pump, 6-in. column 2½-in. oil tube, and 1½-in. shaft with 400-ft. setting, by using four-sheave wire rope tackles.

A more improved type of puller has been built which consists of a heavy lift hoist, such as is used in machine shops, forge shops and foundries, which is driven by an enclosed motor operated on 220 or 440 volts, and equipped with a solenoid-type motor brake. The drum is grooved for the steel hoisting cable. This completely self-contained unit, with switch box, is mounted on a body on four steel wheels (these should have been rubber tired). It is pulled up outside the pump house and is ready to work when the necessary blocks are rigged up.

Portable equipment for cutting large size pipe, 6 in. in diameter and greater, and also for threading it in the field, is desirable.

Welding—Riveting

Field welding will be much more satisfactory and will be more extensively employed if it can be tested with the same facility and accuracy obtainable under shop conditions. Adoption of shop equipment and technique to meet field conditions would be of the utmost of value.

For cover-plate work, a light yoke riveter, mounted on a frame so it can be moved along a stringer, floorbeam or girder, will drive more rivets with far better results as to filling the holes, and as to appearance, than is possible with regular pneumatic hammers.

A self-plugging rivet, comparable in shear strength to a solid rivet, has been developed to be driven where only one side of the structure is available to the riveter. This consists of a hollow rivet, and a stem with an oversize end. With the oversize end pushed through the rivet, the rivet is stuck through the rivet hole from the front side. The pulling head of a special gun engages the rivet stem which, as it is pulled through the hollow rivet, expands the shank of the rivet. When the oversize end of the stem is pulled entirely into the rivet, it is cut off at a notch. The broken section of the stem is ejected from the gun, and the stem left in the rivet is trimmed flush with the rivet head. These rivets are now available in sizes not larger than 9/32 in. in diameter. They would have to be increased to ¾ in. and ⅞ in. in order to be suitable for use in steel railroad structures.

Paradoxical as it may seem, the elimination of riveting entirely may be in the offing. There is a feeling among bolt manufacturers that a bolted joint can be developed as strong as a riveted joint. If such is developed, a lot of time and money will be saved putting in bolts and then taking them out again, as the bolts put in for erection can stay in. However, impact wrenches used to tighten the nuts should be designed to upset the bolt threads so the nuts cannot work off.

Lightweight Tools

Without question the weight of tools and equipment should be reduced as far as possible by the use of the various light metals, such as aluminum and magnesium. For instance, a prominent chemical company is planning to manufacture a wheelbarrow that will weigh 30 lb., or 55 lb. less than the type commonly used. This will be accomplished by making the body of magnesium instead of steel, and the frame of tubular steel. To make operation of the wheelbarrow still easier, it will have anti-friction bearings and a pneumatic tire.

This reduction in weight can be applied to a large number of hand tools, where weight is not essential in their use.

The use of timber for staging, needle-beams and scaffolding could be eliminated by employing light metal platforms, trussed if necessary for greater rigidity. Scaffold fastenings of rope are cumbersome to handle and are subject to damage by cutting and by sparks from cutting torches. These should be replaced with light steel chains with special hooks at one end for quickly adjusting the staging to the right height, and with special attachments at the other end so they can be readily secured to the flanges of steel members, timber stringers, rail, etc.

Conclusion

In conclusion, your committee finds that the manual effort involved in doing work must be lightened to attract work-

men to the railroad, and that all work must be done as economically as possible, if the railroads are to survive.

Recently, your chairman saw a farmer loading a pile of scrap bridge ties on a wagon, using a front-end litter on his tractor. Yet your chairman knows that bridge men had handled each of these ties individually several times when new — off the freight car, onto piles, onto push cars, off of push cars, and onto the deck. Then, when worn out, they were handled out of the deck, onto a push car, and then onto a pile. It seems evident to this committee that there is much room for further improvement in power machines and power tools, and need for their wider application in bridge and building work.

DISCUSSION

Several members commented on the timely aspects of the problems considered in the report when viewed in the light of increased costs of materials and particularly the recent wage increase granted to maintenance employees. Lee Mayfield (M.P.) told of the development of a new gasoline-driven chain saw for cutting off piles. F. M. Misch (S.P.) described a recent development made by a bridge foreman on his road, who combined a push-car derrick with an air compressor and an air motor to produce an air-operated derrick which has performed very satisfactorily.

Development and Training of Supervisory Personnel in Bridge and Building and Water Service Forces

Report of Committee

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THE subject of this report is very important to the railroads of our country, for certainly there must be continued an efficient and effective organization to maintain properly the bridges, buildings, and water service facilities of the railroads. In these days of ever-increasing speeds and of better and more costly equipment, and at a time when railway managements are determined to maintain and surpass the outstanding performance records of World War II, there is cast upon the shoulders of supervisory personnel the added responsibilities and problems of maintenance which these conditions have produced and which, we believe, will continue to become more complex in the years ahead. It is obvious then, that too much stress cannot be placed upon the proper training of the supervisory personnel in this particular field of railroad operation.

In this report we shall deal only with the term "supervisory personnel" as it applies to the bridge and building and water service forces. These forces are closely related, and on the majority of railroads are under the direction of the bridge and building supervisor. There are exceptions to this arrangement, however, especially on the larger roads, where the volume of work and uncertain sources of water supply require the full time of a supervisory officer to direct properly the activities of the water service forces.

A supervisor is, as his title implies, a "super-man"—one who is above the average of his fellows in ability, intelligence and aptitude for his work. He should be able to command the respect of those under his supervision to the extent that his orders and instructions will be carried out. It is very essential that he be able to plan and coordinate the work of the various gangs under him so that projects may be completed rapidly and economically. He must be able to understand and work by blue prints, and it is desirable that he have sufficient technical training to enable him to plan and lay out the work to be done by the forces

under his supervision. He should be resourceful and able to cope with situations that are unusual, and also those of an emergency nature. All of these qualifications are developed by training and experience, and for this reason consideration of a suitable training program is of great importance.

Present Training Methods

Your committee has made an extensive survey of present practices on the railroads of the country governing the selection of supervisory personnel and has sought suggestions and expressions which might prove helpful and practical in the future as a guide in the development and training of this personnel. Questionnaires were sent to 58 of the leading railroads in the United States and Canada and 46 were returned in completed form. Approximately 500 supervisors or master carpenters and assistants are employed by the roads reporting.

The results of the survey show that the vast majority of the railroads have no definite training program for supervisory personnel, except that of promoting the more outstanding men from the rank of gang foremen. That this plan has worked throughout the years is evidenced by the excellent record that these men have produced on their respective railroads. These men know how various jobs should be done because they have come up from the ranks and have actually worked on these jobs with their own hands.

A few roads follow the plan of appointing assistant supervisors to work under and be trained by the supervisor. These men may or may not be promoted from the ranks, but in many instances promising young men with technical training and some previous engineering experience are selected. At least one road has attempted to select promising young men from various sources, such as engineering parties, gang foremen, draftsmen, etc. These men are first made bridge inspectors for a period of time, then assistant supervisors, and finally, supervisors, provided, of course, they show the necessary qualifications.

So far as we have been able to determine only three American railroads follow a systematic program of employing technical graduates for training as supervisory officers. Two leading roads have followed such a program for several years. Another road inaugurated such a program during 1946. The plan is a "Student Apprentice System,"" wherein technical men are trained, through actual work with the regular forces, in timekeeping, inspection, office work, etc. At the present time from about one-third to one-half of the supervisors on these roads are men who came up through the student apprentice system. The remainder were promoted from gang foremen. For the sake of morale among the men on the forces, it is the present policy to keep promotions from these two sources on about a fifty-fifty basis.

Officers of these roads report that the student apprentice system is working out very satisfactorily, and that it has produced, and is producing, excellent results. We believe this system has merit and recommend its consideration by those roads employing a considerable number of supervisory personnel. It probably will not be practical of application, however, on smaller roads where the supervisory personnel is limited to a very small number of men.

Qualified Personnel Needed

Several railroads are facing the task of replacing a large number of their supervisors during the next few years. This has been brought about by two factors — (1) Many men of advanced years have stayed on the job through the period of World War II at the request of managements because of man-power shortages, and are now beyond the average age for retirement. Under normal conditions these men would have retired at a more or less average rate, but now the turnover will be very heavy. (2) Several railroads have inaugurated retirement plans supplementary to that of the National Railroad Retirement Board, setting up more or less compulsory retirement at the age of 65 for officer personnel, including supervisors.

Obviously these conditions are presenting a serious problem to those railroads that have not made provision for the proper training of qualified men for replacement. Furthermore this problem is certain to continue unless proper training methods are adopted, because there is every reason to expect that the retirement of men in this category will be above average for at least the next five years due to the abnormal conditions brought about by World War II.

Several roads report that they are now experiencing difficulty in obtaining

qualified men to fill these positions, but there is little evidence that any definite steps have been taken on the part of managements to correct this condition or to plan for the future. Certainly this matter should be given serious consideration and immediate steps taken to overcome it.

Methods of Training

It is the concensus of railroad managements that previous technical training and engineering experience, while not absolutely essential, are highly desirable for supervisory personnel. Investigation develops, however, that to the present time only a few supervisors have had such prior training and experience. This is not to be construed in any way as a reflection upon the qualifications or ability of those hundreds of men now filling these positions in such a capable manner all over the country.

In considering a plan of training and orientation for prospective supervisory personnel who might be graduates from various technical and engineering schools, it should be borne in mind that at the present very few such young men find their way into railroad service. Prior to World War I the railroads were among the largest employers of these graduates, but following this period other fields, such as sanitation and highway work, forged to the front. The railroads, however, were still able to obtain sufficient personnel for their needs. When the depression came in the early Thirties, it was necessary to curtail the hiring of new men, and in many instances, to furlough some of those already on the rolls. When, during the war years a sizeable number of young graduates might have been employed, such were not available.

With these as contributing factors, it is apparent that there has been in recent years a lessening of interest on the part of engineering graduates in railroading as a career. There is also the fact that other industries have and are continuing to offer better salaries than the railroads, at least in the initial years of employment. This situation deserves consideration by railroad managements if they expect to attract the more outstanding graduates of engineering schools.

It is suggested that a training program for such employees might be handled on the following basis: First a period of 12 months or longer should be spent in close contact with the actual work, either working with the gangs or, if this is not feasible, working as an assistant to the supervisor—not assistant supervisor. With this status the trainee could be assigned to various projects and not be limited to the work performed by one gang. During this period he would have opportunity to become acquainted with the general routine office work required of the average supervisor. When this first period of training is over he should be in position to know whether or not he desires to continue in this department, and should be thoroughly interviewed to that end. The next period of at least six months or longer should be spent as a draftsman in bridge, building and water service work. While at this he would become familiar with the system designs and general practices of his road with regard to its bridges and other structures.

From this point the next step should be to the position of bridge inspector on a given territory. We believe this period should be for at least 12 months, and preferably longer. During this time he would have opportunity to assist in the preparation of annual maintenance programs covering not only the bridges, but the entire category of this department. There would also be an opportunity to observe the problems of maintenance and construction resulting from various seasonal changes, as well as those of performing work under traffic without undue delay to train movements. Much valuable information assimilated during this period would be helpful in the future.

If the technical graduate has properly applied himself to the above training program and shows the required ability and interest in his work, he should now be ready for a position as assistant supervisor, provided there is an opening. He would then remain in this position until such time as there is a vacancy as supervisor. This period should be regarded as probably the most important in the entire program, as here he would first begin the handling of men, the planning of work, and the shouldering of responsibility.

Salary

The above is merely a suggested general plan, and is sufficiently flexible to provide for the necessary changes to cover conditions pertinent to locality and management, as well as the aptitude and ability of the individual. There are many

details to be worked out under such a plan. To mention only one, there is the question of wages. We believe the initial salary should be sufficient to attract young men of outstanding ability and scholastic records, with at least some faculty recommendations from their particular schools or colleges. There should, of course, be progressive increases in salary through the various stages of training and development. This feature is extremely important, as many industries canvass the graduates of technical schools annually and offer attractive propositions to those of outstanding ability.

When promoting foremen or other men without technical training to supervisory positions, the committee feels that it would likewise be desirable to have these men serve a period as bridge inspector and assistant supervisor before being elevated to the position of supervisor. It has always been quite a long step between the qualifications required of a foreman and those required of a supervisor, and under present-day methods and practices, the gap is even wider. It is, therefore, desirable and practical that men promoted to supervisor have additional training and knowledge other than that derived from actual gang experience.

For those without technical training, a correspondence school course in railroad engineering should be encouraged. Several such courses are available, and a diploma received after completing any one of them is an indication of considerable effort put forth on the part of the student, and the assimilation of much valuable technical knowledge. To encourage the completion of such courses, it might even be practical for the railroads to refund a portion or all of the tuition fee, providing a diploma is received and, of course, that the man completing the course is still in employee relationship at that time.

Conclusions

It is apparent from the survey conducted by your committee that there is a very definite shortage on many railroads of the country of properly trained and qualified men to fill supervisory positions. At no previous period in history has this shortage been so acute. In spite of this situation, only 4 of the 46 roads replying have made any attempt to step up a definite training program for the benefit of this particular group. Some are considering such a step, but no definite action has yet been taken.

It is further evident that, due to conditions brought about by World War II, and also to the establishment of compulsory retirement programs by many roads, the requirements for replacements of supervisory personnel will be considerably above the normal average for at least the next five years.

Training programs are feasible and practical, as is evidenced by the satisfactory results being accomplished on those roads which now have such programs. Other industries have also been successful in such training programs for the development of supervisory personnel. Therefore, it is reasonable to assume that more roads should find such programs equally successful.

It is also evident that such training programs in the case of technical graduates would be the means of qualifying at least a few men for positions of greater responsibility and importance, such as assistant division engineer and division engineer, after they have served in other supervisory capacities.

In view of these facts, your committee recommends that this report be brought to the attention of railway managements for their earnest consideration, and that they be urged to take immediate steps toward the inauguration of some definite plan of development and training for this branch of supervisory personnel. The benefits derived from such a step, we believe, will more than compensate the railroads for the expenditure required.

DISCUSSION

W. F. Martens (A.T.&S.F.) opened the discussion by saying that he considered the development and training of supervisory employees the greatest problem now confronting the railroads. He added that the initial attack against this problem should be made by the employing officer always keeping in mind the prospective employee's supervisory capabilities.

In reply to a question from the floor as to whether union contracts which some roads have with their employees were presenting any obstacles to training programs, Chairman Hutcheson stated that a few roads mention difficulties of this nature, but that none were specific.

J. S. Hancock (D.T.&I.) spoke of the difficulty his road was having in getting technically-educated men. He said that, in canvassing various engineering schools it was found that the type of man desired was not interested in railroad

work. He illustrated this point by telling of one college employment office which, after bulletining 152 railroad positions as available, had only three of them accepted by graduates. He said that college men had acquired the general impression that seniority, rather than ability, governed promotion, adding he did not believe that railroads will get many men interested in their work until such an impression is dispelled.

F. M. Misch (S.P.) stated that he thought the committee had prepared a good report, but wondered if it could be sold to the management. He said he thought the problem was aggravated by the fact that about 55 per cent of the present force on his road was just holding on while working toward a pension. The remainder of the men, he added, are not capable of assuming greater responsibilities. He stated that in the face of these difficulties, "we *must* develop our trainees."

Inspection of Substructures and Underwater Foundations

Report of Committee

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THE oldest structures in the world are of masonry. There is probably nothing more substantial than a properly designed and constructed concrete or stone substructure. Some such structures need very little inspection under normal conditions. However, all railroads are rightly concerned about the safety of bridge substructures during floods.

Severe floods may not be frequent. Sometimes they occur at frequencies greater than a lifetime. It is entirely possible, therefore, that the men responsible for the safety of substructures during a flood may never have experienced a similar emergency, even though they have been inspecting and maintaining bridges for many years. It is the aim of this report to relate the experiences of men who have been responsible for the safety of substructures during floods, so that those with less experience may profit thereby.

Rainfall and Flood Frequency

Annual rainfall in the United States varies from 10 in. to 100 in., but regardless of this variation, there are five recognized generalities.

(1) Intense storms usually cover only small areas and are of short duration. Rainfalls of 1 in. to 2-1/2 in. in 10 to 15 min. over small areas have been recorded at nearly all weather stations. These are sometimes called flash floods.

(2) Storms lasting several days cover large areas and fall at low intensity.

(3) The magnitude and intensity of any storm bears a direct relationship to its average frequency of recurrence.

(4) There appears to be no close relationship between the total annual rainfall at a given locality and the number or magnitude of intense storms likely to occur in a given time period.

(5) The total annual rainfall gives a good indication of total volume of runoff, most of which occurs at less than critical rates.

We feel justified in giving some consideration to measures taken to prevent wash-out accidents. One of the problems that confronts us today is how to prevent a train running at 100 m.p.h. from entering territory where bridges or track have been washed out or made unsafe by a flash flood, with water traveling at 20 to 30 m.p.h. This calls for teamwork and quick decisions by both the operating and engineering departments.

All railroad employees should be on the

alert to get all available information concerning severe storms. In the engineering department the chief storm spotter is the section foreman. All books of rules make it his responsibility to report storms and to patrol track. With present-day long sections this is a difficult assignment. Section foremen should be encouraged to use local telephones to keep informed concerning rainfall, and all section foremen should know all methods and routes to reach dispatchers by wire. The record of these 24-hour-a-day guardians of safe track is very good and they are entitled to our encouragement.

It is possible to obtain reports from points off the railroad and several railroads report that they have established contacts for rainfall and storm information from state highway departments, government lock tenders, other railroads, and direct from weather bureau offices. Forecasting storms is one of the most legitimate functions of the government, and it is the duty of railroad officers to keep the channel for this information open, even for the storm which comes but once in a lifetime.

Rules and Instructions

Several books of rules were examined and a questionnaire was sent out to determine precautions taken by railroads during floods. In our questionnaire we asked, "Are trains ever operated on your railroad under instructions to enginemen, 'Look out for high water conditions'?" The answers showed it is a common practice. One railroad produced a book of special instructions issued to all operating employees, such as superintendents, dispatchers, and trainmasters, as well as to master carpenters, bridge foremen, roadmasters, track foremen, track supervisors, bridge and building supervisors, etc., which contains a rule reading as follows:

"Trains must not be operated under instructions to enginemen to, 'lookout for high water conditions,' nor should train and enginemen be told to determine whether it is safe to use a bridge which may have sustained damage by reason of high water. These employees do not have equipment or tools to ascertain such conditions and generally their experience and training are such that they do not have the knowledge to evaluate accurately the information that they might obtain."

There are still in force on many railroads rules which, while a little ambiguous, seem to designate conductors and enginemen as competent bridge inspectors. One such rule, sometimes called the "between stations" rule, is as follows:

"When overtaken between stations by a severe storm or indication of high water which threaten damage, trains will proceed at restricted speed. Conductors and enginemen will examine bridges and culverts or other places subject to damage by high water and if they find any indication of danger will, on arrival at the first point of communication, notify the agent or operator, report by wire to the chief dispatcher, and not proceed until instructions are received."

Where this rule is still in effect it should be interpreted to mean stopping the train and getting to the nearest telephone to make report. We feel sure that the men who operate trains prefer to have the engineering department examine bridges and culverts. This rule is being changed in the more up-to-date books.

In our questionnaire we also asked, "Who is authorized to permit trains to proceed across bridges where water is over the ties?" It was considered that this is a definite condition which can be immediately recognized by enginemen and conductors, and that the practice followed on different railroads would be interesting. One small railroad indicated that this was the responsibility of the engineer of maintenance. Most larger railroads named division officers, such as supervisors of bridges and buildings. roadmasters, or division engineers.

Some railroads have time card rules similar to the following:

"Streamliner-type trains and gas or Diesel-electric motor trains and engines must not be run over inundated track if water is more than five inches above top of rail, and when operating through water speed must not exceed 6 m.p.h."

Where such rules are in effect, all concerned should know that they prohibit operation, even though track and bridges are safe, and that under such conditions trains should be permitted to proceed only on signal from a flagman authorized to act for a representative of the engineering department.

Operating department men and those in the engineering department all know that trains can not and should not be stopped for ordinary rain storms. When to hold trains must always be a question of judgment, but it is well to have some generally recognized authority on which to base such judgment. We quote at

length from instructions issued by a large western railroad, which we have selected for this purpose.

"*General* — If a sectionman, bridgeman, operator, other station employees, trainman, engineman, dispatcher, or any other employee, supervisor or officer, has reason to think a condition exists or threatens which casts a doubt as to safe train movement, his first obligation is to take appropriate action to stop trains immediately; and his second obligation is to assist, according to his position and the circumstances, in determining the actual conditions.

"*Handling Trains During Flood Conditions*—When there is doubt, the most important thing is, first, to stop and find out whether it is safe to proceed, rather than to keep moving until it is known to be unsafe to continue. There is a vast difference between these two courses, and a clear conception of that difference is the greatest single principle to keep in mind.

"If in an abundance of caution trains are stopped when subsequent investigation reveals that such was unnecessary, there will be no criticism. Obviously, if trains are stopped each time they should be under these instructions they will occasionally be stopped needlessly.

"Whenever trains are stopped pending inspection and determination of actual conditions, they must not be released until the conditions ahead are known, beyond a possibility of doubt, to be safe at the specified speed. Trains must not be so released when there is any possibility of danger either by cutting or scouring action of water, or by bridges, etc., floating down the stream.

"At times, trains may be released by having maintenance of way employees on motor cars precede them. Whenever this is done the train must move at 'restricted speed' and there must be a clear understanding between the men on motor car and the train and enginemen concerning the signals or other information to be given by, or received from, the men on the motor car.

"In other instances, watchmen should be stationed at proper locations where they may stop or otherwise control the movement of trains. Whenever this is done the speed of a train approaching the location of the watchman should be at 'restricted speed', and there should be definite understanding with train and enginemen concerning the advice to be obtained from the watchman and the manner in which that advice is to be furnished. When conditions warrant, trains must be stopped, and proceed thereafter only as authorized.

"Particular care must be exercised in some locations to guard against difficulties during ice gorges, or when ice is breaking up and moving freely."

Inundated Track

We attempted to secure through our questionnaire information that would help an engineer to know under what conditions it is safe to operate over inundated track or damaged bridges while the water is still high. It seems as though this usually calls for getting all the information available by wading, sounding, and probing with the best obtainable tools. This information is then checked against plans and office records, using telephones and telegrams where necessary. There is nearly always a conference between the engineer and the more practical men, such as section foremen, bridge carpenters and supervisors of bridges and buildings, who are apt to have more knowledge concerning previous floods and local conditions. After such considerations, trains can often be moved over inundated track with safety and without great delay. Cases were reported where loaded cars were placed on flooded track, both to hold it down and to test it.

It is important that after any unusual high water a more careful and complete inspection of all substructures should be made than could be undertaken before the flood subsides. During such an inspection the expansion of steel spans should be carefully noted and compared with previous records. Unusual expansion is very likely to indicate a tipping or movement of an abutment or pier. The height from base of rail to the lowest point in the waterway should also be measured and compared with the distance from base of rail to bottom of footing, as shown on the plans. In this connection, it is important to note the record of piles as shown on the plans or in other records. If there is a question concerning the existence of piles, it will be well to do some excavating to settle the question. The judicious use of a shovel has been known to reveal very interesting and surprising facts. One of the members of our committee, the engineer of bridges on a mid-western railroad, reports as follows:

"It was a rather interesting experience years ago to be sent out to inspect an

abutment on the Wabash river, at Logansport, Ind., that was reported as riding rough. The water was low and away from the abutment. The abutment was high and there was a vertical crack the full height at about the junction with the 30-deg. wings. I felt sure the abutment had settled a little due to excess toe pressure and started to leave the site with such a report in mind. However, seeing a house not too far away, I went over and borrowed a shovel. I had to dig down only about 2 ft. to get to the bottom of the footing and found that I could not only push the full length of the shovel under the abutment, but could even turn the blade around.

"During a previous very high water, the high fill had washed out back of this abutment for a considerable distance. A temporary trestle had been built and new fill placed before the water had entirely receded. This abutment had undermined from the back side, which is possible, but to me is still unusual. By carrying this abutment six feet deeper, it would have had a solid rock foundation. However, in those days, they didn't pay too much attention to foundation depth. We dug down to the bottom of the abutment, rammed in sand and gravel by hand as lightly as possible, then solidified this by grouting."

A large eastern road gave us an account of a very systematic method of taking soundings and keeping records. For all river bridges where there is any active erosion, this railroad has layout plans of abutments and piers, with points indicated at which depth from bridge seat to streambed are to be measured. These points are marked by circled numbers. The inspector is furnished with a boat and with pipes for taking soundings in deep water.

The plan is marked up each year and gives an excellent case history of the erosion that takes place. Substructures resting on rock are not kept off this list, and a case was sighted where these yearly soundings showed erosion taking place under piers resting on natural rock. The bridge inspector was able to do some probing under the footings and his findings were checked by a diver. The area around the piers was dewatered, and when mud and loose material were cleaned away it was found that the footings were sound but that parts of a leveling course had been eroded away. The piers were protected by a concrete encasement, completely around the piers, and carried down to bed rock.

All roads questioned indicated the infrequent use of divers to determine the underwater condition of foundations. In the case of the few structures where the water is deep and some combination of erosion, excessive vibration, settlement, age and inadequate design are known facts, a diver is sometimes used. His services usually cost about $100 a day, from the time he leaves his headquarters until he gets back, together with all travel expenses and pay for his assistants. A large eastern railroad reports using a diver having an outfit equipped with a telephone. This makes his work much more efficient as he does not have to come to the surface to report.

Regular Inspection

Regular inspection should always be started by knowing the year in which the structure was built. If it is of recent adequate design, a quick visual inspection of the exposed portion is all that is required. The only necessary record is a check mark, the date of the inspection and inspector's initials.

When the date of stone construction is back in Civil War days, the inspection should be much more deliberate and in far greater detail. A pointed hammer or a timber inspection bar is used to sound stones that appear suspicious. A sketch is often made of arches or abutments to show the location and extent of disintegrated stones and cracks. All plans are carefully considered. Unless masonry structures of such age are unusually well preserved, consideration should be given to rebuilding them, or to subjecting them to major repair and strengthening operations. It is important to take care of the poorest of such structures first, and it is necessary to have as accurate a picture as possible of the condition of each of these old structures. Usually, the concurring opinion of more than one competent technical engineer is necessary to secure the consent of management to the expenditures necessary for rebuilding or major repair and strengthening work.

The rate of increase in the size of cracks is an important matter to consider. The record of cracks is best kept by placing two indicator boards edge to edge, with the ends of each anchored to the masonry on opposite sides of the crack. A saw mark is then made across the two boards and any increase in the size of the crack is at once indicated by the saw marks being out of line. There have been cases where there was great concern about cracks in stone and con-

crete substructures, but this concern disappeared when such indicator boards showed no development in these cracks over many years. One western railroad reports that these boards have indicated slow or no movement in most cases.

The defects that are found in stone masonry, mass concrete and cylinder pier substructures during routine inspections, and which are of interest, should be carefully described when the inspector intends to request authority for rebuilding, or where repairs are unusual or extensive. The following is from the Instruction for the Inspection of Bridges on a large railroad.

"*General Abutment and Piers*—General overloading of foundation, indicated by vertical settlement or pumping.

"Local overloading of foundation, indicated by sagging of the horizontal joints, open vertical cracks, and crowding of backwalls towards the span.

"Tilting of a part of or the entire substructure, indicated by shearing of anchor bolts, displacement of expansion rollers, and reduction of clearance at ends of spans.

"Horizontal movement, that is, sliding on foundations without tilting, indicated by changes in vertical or inclined surfaces, and the symptoms listed under 'Tilting'.

"Weakening of the foundation, caused by scouring or undermining.

"Whether soundings are necessary to determine what should be done.

"Failure of bond between stones, indicated by the looseness or the absence of mortar at joints; vertical cracks caused by uneven bearing; bulging of parts of surface, indicating internal failure.

"Overloading of individual stones, indicated by split or broken stones, usually directly under the bearings or in the course below the bearing stones.

"Disintegration at the water of ground line, caused by frost.

"Surface disintegration of stones, indicated by weathering, spalling, laminating or slicing, and breaking out of small parts.

"*Concrete Structures* — Whether weathering and disintegration result from improperly proportioned materials, indicated by a porous condition; poor placement methods, indicated by laitance spots or seams; stone pockets and surfaces spalling due to freezing or loss of surface water through the forms; seepage through concrete, indicated by crystalline efflorescence on the surface and by discoloration from chemical action. Surface absorption of moisture which corrodes the metal reinforcement also softens the aggregate and causes breaking up by alternate freezing and thawing.

"*Cylinder Piers* — Displacement of cylinder piers by ice pressure; horizontal movement of piers on natural rock and in shallow water; tilting of piers on piling and in deep water. Drainage from top of pier to prevent damage from water freezing between concrete and shell.

"*Arches*—Condition of stone in arch ring and parapet walls; settlement cracks in barrel; sliding of parapet walls on barrel of arch; movement of wings and ends of barrel; extent and location of leakage through barrel of arch."

Movements of Abutments

One of the most common defect of old masonry abutments where the ratio of height to base of footing is high is for them to tip in, showing this movement by sheared girder anchor bolts or excessive expansion on rollers, and finally by the backwalls coming in contact with the steel. Where this movement is slow, as 1 in. to 4 in. in 50 years, it can usually be tolerated until a more rapid rate of movement is noted or other defects become evident. Where tipping is the only consideration, repairs have been made by chipping out the backwalls to prevent damage to the steel.

Where it has become necessary to stop the tipping movement, one western road reports that pile bridge-approach spans have been built to take part of embankment load from the abutments. This road also reports placing steel struts between abutments where the span is short and the abutments are high. In other cases the abutments are anchored with rods passing through them to steel sheet piling driven in the embankment. Consideration is being given to bracing such abutments and backwalls with concrete buttresses. The necessity, economy and effectiveness of these various types of repairs might well furnish the subject for a future report.

Inspection Personnel

All railroads maintain some system of bridge inspection. There are, however, a great variety of titles for, and many different opinions concerning the qualifications of, an inspector. Our questionnaire revealed that one small railroad considers that a bridge carpenter with high

school education, 5 to 10 years' experience, and a reliable character, is qualified to inspect structures and report defects. The engineer of bridges qualifies this, however, by stating that, "In case unusual conditions are found, any man who is not a competent designer would need immediate assistance from the bridge office to check and interpret his findings." On a small railroad this assistance might be quite immediate. On a larger railroad, however, the inspector might be 1500 mi. from the bridge office.

In contrast to this, the engineer of bridges of a large western line states, "The bridge engineer is also responsible for the inspection of all steel and concrete structures." This bridge engineer spends a considerable portion of his time on the line acting as an inspector and has no difficulty in obtaining immediate assistance from the bridge office to check and interpret his findings. It might be said that the bridge office is at the point of inspection. No doubt he can also secure readily the advice of practical men who have spent years building and repairing bridges.

On another large western railroad the engineer of bridges reports that division engineers and chief carpenters are responsible for inspection on their respective divisions. He states further that all division engineers are college graduates with considerable railroad experience. His chief carpenters are men who have had long experience with the railroad as bridge foremen or with some other responsible duties before taking over the job of chief carpenter.

All answers to our questionnaire indicate the frequency of inspections as at least twice a year. Usually one of these inspections is made with a qualified technical engineer as the head of the inspection crew. It is quite generally stated that more frequent inspections are made of some structures.

From the information collected, it is quite evident that two types of men contribute to any system of bridge inspection. One type is the competent technical engineer, usually a college graduate, with considerable railroad experience. These men, to an increasing degree, are receiving recognition by law as registered professional engineers. The other type is the chief carpenter, or supervisor of bridges and buildings, who has had years of experience in the actual building and repairing of bridge substructures. The fact that both types are trusted to inspect, and thus control the standard of maintenance and safety of, the railroad bridges of the country, with so little governmental control, is evidence that they are men whose judgment and reliability are generally recognized. They are also outdoor men of courage who can make quick decisions, even to the point of stopping traffic. Their record is excellent, for bridge failures are not frequent. There are many of both types in this association.

DISCUSSION

Commenting on that part of the report dealing with the inspection of foundations during and after high water, F. M. Misch (S.P.) outlined his road's method of permanently marking the lengths of piles, etc., so that the effect of scour can be determined quickly in the field. He said it was their standard practice to drive nails, in the form of numerals, into the outside pile of each bent, both on the upstream and downstream side to show the minimum penetration of piles below cut-off in that particular bent. On concrete bridge piers, figures are cast in the concrete to indicate the depth from the top of pier to the bottom of concrete. In the event that such piers are supported on foundation piles, numerals are cast in the concrete below the others to indicate the depth from the top of pier to the bottoms of the piles. Thus, 40 over 75 would mean that a 40-ft. pier rested on 35-ft. piles. He stated that this method had been very effective in determining the safety of bridge foundations during high water.

B. C. Phillips (C.B.&Q.) closed the discussion by saying that his road uses a system similar to that described by Mr. Misch, except that the nails are driven as Roman numerals instead of Arabic. He added that stainless steel numerals are fastened to the fenders to show the same information.

Safety Measures to Protect Employees Within Buildings Against Fire and Accidents

Report of Committee

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THE subject of this report covers practically an unlimited field, and is of such scope that the committee did not find it possible within the space allotted to deal with the various measures involved in as much detail as it would have liked. This report, therefore, is necessarily of a general nature.

For convenience, the report is divided under two general headings — "Fire" and "Accident," and protection therefrom.

To discuss the protection of employees in buildings against fire is rather difficult without going into the realm of fire prevention, detection, and extinguishment. However, we will assume that these three things have been adequately taken care of and will deal only with the prevention of injuries and fatalities resulting from fire and panic.

However remote we may consider the possibilities of tragedy or disaster on our own properties, such things as the recent epidemic of hotel and industrial fires, climaxing, so to speak, with the Texas City disaster, should have done more than anything else to make us realize our responsibilities as employers and public servants.

Exit Requirements

The fire-safety of building occupants probably depends more on the ability to evacuate the building in case of fire than on any other factor. Of the approximately 10,000 deaths due to exposure to fire in the United States each year, a very large majority can be traced directly to inadequate or blocked exits.

Exit requirements depend on several factors, including the occupancy of the building, the fire hazard presented by the building's construction, and the materials and processes contained within the building. A principal factor is whether or not the building is equipped with automatic fire sprinklers.

The following exit requirements should be considered as minimum requirements for existing structures: In a building of high-hazard occupancy, that is, where there is danger of rapid burning, explosion or toxic gases, no portion of the working area should be more than 75 ft. from an exit; for medium hazard or moderate burning without explosion or toxic gases, 100 ft.; and for low hazard with automatic sprinklers, 150 ft.

It is generally recommended that for high-hazard occupancy, where the floor area of any story exceeds 2500 sq. ft., two exits should be provided as remote as possible from each other, and assuming an occupancy of one person for each 100 sq. ft. of gross floor area, the exits should provide 22 in. of width for each 30 persons. However, when the stairways from upper floors are enclosed by fire-resistive materials, and the building is equipped with automatic sprinklers and classed as a low-hazard occupancy, these requirements may be reduced by 50 per cent, but any work area should not have less than two exits. When the foregoing requirements cannot be met in older existing structures, the population of these structures should be limited.

All exits should be plainly marked, and illuminated if necessary, so they will be visible from any part of the work area, if possible. If it is not possible to see certain exits, adequate directional signs should be provided.

* Deceased.

Material should not be allowed to accumulate near exits or to block passageways leading to them. Exits should not lead to other enclosed areas, such as enclosed court yards, and when it is necessary that they lead to alleyways, precautions should be taken to see that such areas are kept clear.

On some older multiple-story buildings, narrow and steep outside wood stairways and ladders are to be found. These should not be considered as fire exits under the recommended minimum requirements as they are not safe for the purpose. Also, elevators should not be considered as a means of emergency escape.

Stairways—Windows

Inside stairways, including all landings, should be enclosed with fire-resistant material and be accessible through outward swinging doors of the self-closing type. Stairways should be accessible without the necessity of passing through any locked rooms and, when necessary, direction signs should be provided.

Open outside stairways or fire escapes should be regarded as nothing more than a secondary means of escape and, generally speaking, should not be used on buildings over four stories in height. For frame buildings, outside stairways of wood construction should not be allowed on buildings over three stories in height, and then only for low-hazard occupancy buildings.

Outside stairways or fire escapes should not be less than 29 in. wide between hand rails, and a width of 44 in. is to be preferred. In any case the width should conform to the exit requirements previously given, excepting in existing buildings, when remodeling would be extensive, 40 in. would be acceptable as two exit units and 36 in. as one and one-half exit units. Stairways should not exceed 45 deg., and a 10½-in. tread with 7½-in. riser is recommended.

Where windows exist adjacent to outside fire escapes, they should consist of wire glass in metal frames for a distance of 15 ft. horizontally from any portion of the fire escape and for a distance of 35 ft. below and 10 ft. above, measured vertically. Much to be preferred are outside stairways within so-called "smoke proof" towers constructed of fire-resistant materials and separated from the building by a fire wall, with the entrances protected by fire doors.

Fire Doors—Warning Systems

Fire doors should be of either an automatic, or self-closing, type; they should be reasonably smoke tight and should correspond at least to the fire resisting qualities of the wall or partition in which they are placed. They should be prominently marked and precautions should be taken to see that their self-closing, automatic features are properly maintained.

Generally speaking, some type of fire warning system should be provided in any building containing 40 or more persons, and, if manually operated, the sending stations should be prominently marked and kept clear at all times. Approved closed-circuit electric alarm systems are recommended and should be connected with the local fire department or central protection agency. Of new interest is an industrial smoke detector recently placed in the market, designed to detect fire in storage or record vaults, or other locations in industrial plants or buildings. This detector, which has an enclosed light beam, operates on the principle of a photo-electric cell. Air samples are continuously drawn into a detecting chamber where, at the first sign of smoke, an alarm is sounded.

Regardless of how adequate the means of escape and fire protection, or the type, use and size of the building, the evacuation of the building should be carefully planned, and as much information as necessary conveyed to the occupants. To minimize the possibility of panic in large-occupancy buildings, regular fire and emergency drills may be held. Such drills should be carefully planned and carried out under rigid discipline. In some cases the type of work being done may preclude the possibility of such drills, and printed instructions distributed to the occupants and posted in prominent places, with a trained exit organization, may be the answer. Such an organization might, in large buildings, consist of a leader, floor monitors, exit guards, etc. Each of them and those under them should be assigned to specific tasks, such as opening exit doors, regulating traffic, assisting people down fire escapes, etc.

Spread of Fire

While precautions to prevent the spread of fire may properly come under the heading of fire prevention, the subject is so closely allied to protection of

personnel that it is believed there should be some discussion of the subject. While the term "fire proof" is often given to buildings constructed of non-combustible materials, the term is actually misleading. Such buildings should be more properly termed "fire resistant," and their fire resistance depends on their ability to withstand damage caused by the burning of the combustible materials within them. Even within a so-called "fire proof" building, precautions to retard or prevent the spread of fire should not be overlooked.

Fire may be spread from one unit to another in the type of building referred to through ventilating ducts, wall openings, elevator shafts, stair wells, etc. The more widespread use of air-conditioning systems, with their many ducts, gives us many added possibilities for the spread of fire, especially when such systems are installed in older structures. The passage of fire through air-conditioning, ventilating, and air-heating systems can be controlled by the use of fire-resistant materials in the duct work and by the installation of automatic controls which close openings, shut off fans and blowers, and set off fire alarms and the sprinkler system, if provided.

In remodeling existing structures of frame construction, or when placing new partitions in fire-resistant structures, the value to be gained from the use of fire-resistant materials should not be overlooked. These may vary from the use of wood which has been subjected to fire-resistant treatment to certain asbestos and asbestos-cement products. Some of the asbestos-cement products suitable for sheeting, wall panels and partitions not only give a high degree of fire safety, but are economical in other ways.

For those who may wish to pursue the subject of fire-safety in more detail, the following references are given:

National Board of Fire Underwriters Building Code
Central Station Protective Signaling Systems
National Fire Protection Association Handbook of Fire Protection
Nat'l. Fire Code for Building Construction and Equipment
Employee Organizations for Fire Safety
Building Exits Code

Protection Against Accidents

In new building construction, preplanning in design and layout of the proposed structure has long been recognized as a necessity to secure efficiency in its intended function. Pre-planning for the safety of the employees occupying the building has, perhaps, in the past, not been given the recognition it deserves. However, we have now come to realize that accident prevention is a part of efficiency, and, if disregarded, prevents us from reaching our intended goal.

In this report, we shall discuss the practical things that may be done to overcome past shortcomings, and changes in the function of existing structures, rather than new construction.

Safe access to all parts of a building should be provided, regardless of the frequency with which they are visited. It is all too common to find in the isolated attic, the back corner of the basement, or around boilers, etc., where maintenance forces must go, makeshift ladders and steps that are tolerated because the thought is "no one ever goes there," or "only one man uses that."

Stairways

Stairways are much to be preferred in place of fixed or portable ladders and should be constructed to definite standards as to slope and width, considering their purpose. Main stairways, or those used for general ingress and egress, should be conveniently located to the working areas and should not be obstructed at top or bottom. They should, if possible, be alike in width of tread and in height of riser. Stairways for general use should slope between 30 and 35 deg. from the horizontal, and should never, under any circumstances, be under 20 deg. or over 50 deg.

It is recommended that no stairway for general use be less than 44 in. in width. Stairways for special purposes, used by a limited number of persons, may, of course, be narrower. Stairways having four or more risers should have hand rails, and the American Standard Code requires the following:

Width less than 44 in., sides enclosed—one hand rail on right side descending.
Width less than 44 in., one side open—one stair railing on open side.
Width less than 44 in., both sides open—one stair railing on each open side.
Width over 44 in., and less than 88 in.—one hand rail on each enclosed side and one stair rail on each open side.

Width 88 in. or more—one hand rail on each enclosed side and one stair rail on each open side, and one hand rail down the center.

When the stringers do not provide protection, toe boards should be placed extending at least 3 in. above the nosing and open landings should also be so protected. Stair railings should be 40 in. in height and hand rails between 30 and 34 in.

The hazard of worn, uneven steps should not be overlooked. Wooden stairways are sometimes found worn to the extent that the nail heads are exposed sufficiently to cause a slipping hazard. Simply setting the nails will considerably reduce the hazard until more proper repairs can be made.

When stairs become slippery due to the action of traffic on the material of which they are constructed, the hazard may be overcome by the application of various kinds of anti-slip materials. Some of these are painted or troweled on, and others are similar to emery cloth and are glued in place.

A not uncommon hazard, particularly in the case of women with high-heel shoes, is the additional steel nosing and partial tread to be found in some older buildings. This may be alleviated by filling in behind the metal, which is generally about ⅛ in. thick, with linoleum or other suitable material.

It is realized that the remodeling of stairways in existing structures can be a costly job, but the possibilities in such work should not be overlooked when other remodeling or repair work is being done. However, a large measure of safety may be had by seeing that proper hand rails are provided, that no slipping hazard is present, and that proper lighting is afforded. All of these things can generally be corrected at nominal cost.

Floors

Worn or slippery floors can be a prolific source of accident. Wood floors that are uneven or tend to splinter may be resurfaced with one of several different products on the market. Most of these products are an asphaltic emulsion with some type of binder, and can be troweled to the thickness desired. If the proper type is used it will stand hard industrial usage. Another method that has proved satisfactory in offices is to install plyboard and a suitable cover, such as linoleum or asphalt tile.

For floors in small areas that tend to become slippery due to the process being carried on, the type of anti-slip material that is glued on has proved satisfactory. Where oily or greasy conditions are caused in a small area, one of several blotting materials may be spread on the floor to absorb the material during the work period and then swept up.

In the installation of concrete floors, particular attention should be paid to the finishing, so that undesirable conditions are not obtained. In one type of anti-slip concrete floor the desired quality is built in by allowing the expanded metal reinforcement to be exposed at the surface. This "Cloisonne" work has excellent anti-slip qualities.

Use of Color

Where built-in safety is lacking, a surprising amount may be provided with nothing more than the old paint bucket, plus imagination, and the use of data available as the result of studies made in the field of color. These studies have to do with the effect of color on lighting and its psychological effect on people.

The desirability of painting danger areas or signs in red, and impaired clearances with black or yellow and white stripes, to draw attention to them, is well understood. Also, the painting of passageways throughout a shop area, with some distinctive color to guide traffic and keep such areas free of stumbling hazards, is quite widely accepted. Not so well understood is the use of color to create a harmonious state of mind in the shop or office worker, as well as to improve seeing conditions.

This new color science may be likened to the opposite of camouflage. An all too familiar sight is the shop building with walls painted grey, and sometimes black to hide the dirt, and all machinery painted dark grey or other similar shade. This sameness of color can be as tiresome and boring as any other type of repetition, resulting in a surprising amount of indifference on the part of the employee, as well as reducing his seeing ability. We know that indifference and poor seeing conditions breed accidents.

In removing this old-time camouflage and light-blotting color scheme, we might start by painting the ceiling such a color as sky blue, to increase lighting efficiency and make it appear higher; walls a light green, to "push them out" and produce a harmonious contrast; the bodies of machines a light grey or green, and their tools, or working areas, light buff, to

produce contrast with the material being worked and the bodies of the machines. Controls might be painted the same color as the tool area, and those items to which we wish to bring particular attention, bright orange.

In a large railroad machine shop where the latest theory in the use of color was worked out and applied, the first winter saw absenteeism drop 50 per cent, material spoilage practically eliminated, and accidents reduced to the vanishing point. Practically all the large paint manufacturers have made a study of these color phenomena and will work closely with anyone wishing to take advantage of their benefits.

Illumination

In the interest of safety and efficiency, adequate lighting is a "must." The amount of general lighting or supplemental individual lighting required for various operations is a problem for special study by the illumination engineer.

The problem of illumination and its psychological effect have to do not only with inadequate quantities of light, but with poor quality of light, such as glare. Light poor in quantity or quality results in fatigue, which directly affects the accident rate. Accidents also occur when people cannot see what they or others are doing, or cannot quickly detect moving objects or equipment or other hazards.

If we have a general knowledge of lighting requirements and accepted standards, many obvious cases of poor lighting may be corrected without the assistance of the illumination engineer. Some very general requirements follow:

For natural general lighting, if only one wall contains windows, the width of the room should be less than twice the height of the top of the windows from the floor. If windows are in two parallel walls, the width of the room should not exceed six times this window height. In general, single-story industrial buildings should have a window area of at least 30 per cent of the floor area.

To maintain good seeing conditions, some form of artificial lighting is required in any work area. Such lighting should give equal illumination over the entire work area so that changes that might be made in functional requirements will not require expensive changes in lighting.

The amount of general lighting required should be at least 10 per cent, and preferably 20 per cent of any supplemental lighting necessary for specific tasks, as the general lighting should not only provide for general seeing, but for keeping the brightness contrast between the supplementally lighted work and the surroundings within a degree which is comfortable to the eyes.

For further study of this important subject the following references are given:

Eye Hazards in Industry—Louis Resnide.

Recommended Practice of Industrial Lighting—ASA. Standard A-1101942.

The reports of surveys and studies made in various industries by the Illumination Engineering Society, 51 Madison Avenue, New York.

Remodeling—Electrical Hazards

When an existing structure is remodeled or its function changed, its load capacity should be checked. Structural failures have occurred when additional or new types of machinery have been placed, or new types of handling equipment, such as fork lift trucks, have been put into use in older buildings. One case is known where a lift truck put to use in a warehouse went through the floor with resulting serious injury to the operator.

A not uncommon hazard to building occupants is the misuse of electrical equipment. Even though the general wiring and other installations meet Code requirements, there are still hazards that may be set up.

Some of the more common hazards are the replacing of fuses with pennies or other metal objects, the overloading of circuits by unauthorized installations, the use of extension cords, when permanent wiring should be installed, the failure to ground portable hand tools, and inadequate guarding of exposed conductors.

For safety and efficiency the location of electrical equipment should be carefully planned. Control boards, switches and other apparatus should be installed so that the possibility of accidental contact with them is reduced to the minimum, and, when necessary, they should be protected by special guarding. No electrical installations should be allowed to be made except by a qualified electrician, and frequent inspection by such qualified persons is a "must."

Replacing the old style fuses with circuit breakers will eliminate the pos-

sibility of tampering with this all-important feature. The importance of adequately grounding all electrical hand tools or other portable appliances, as well as the exposed metal parts of fixed equipment, should not be overlooked.

It is generally recommended that all portable appliances operating at 90 volts or more to ground be grounded. In any case, the National Electrical Code and any state or municipal codes should be followed.

Other Considerations

While not generally considered from an accident prevention standpoint, adequate sanitary facilities can mean a great deal in maintaining the health and morale of employees. Given the opportunity for personal hygiene, the employee's sense of well-being and self-respect will be fostered, as well as protection against industrial and communicable diseases. Sanitary facilities should include not only toilet and washing facilities but an adequate pure drinking water supply, locker rooms and, in some cases, showers.

In all buildings where high-pressure steam lines are installed for heating or other purposes a shut-off valve should be installed in the steam supply line in an accessible location immediately outside of the building. This is so that, in the event of an emergency, the steam supply can be quickly shut off.

The scope and limits of this report will not permit a discussion of the all-important matter of the storage and handling of inflammable materials, such as gasoline, turpentine, etc., in buildings. However, your committee earnestly suggests that members of the association inform themselves on this subject and, if in need of help, they contact proper authorities, such as municipal fire departments, the National Board of Fire Underwriters of the National Fire Protection Association, for specific information relative to the problem at hand.

In spite of all we might do to provide built-in safety in any structure, the largest part of accident prevention depends on eliminating so-called unsafe practices, and our best weapon in this respect is an educational program designed to teach safe working habits, to make our employees safety-minded, and to build up morale.

Glued, Laminated Members in Bridges

Report of Committee

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LAMINATED structural timbers, made by gluing thin material together to provide necessary length, width and thickness, are finding their way into many new fields of usefulness. One of the newest fields is in railroad bridges. One of the first uses in a railroad bridge involved 11 stringers installed, in October, 1944, in one panel of a creosoted timber ballast-deck trestle for test purposes. The stringers were made of 21 thicknesses of 3/4-in. southern yellow pine (short leaf), Grade C and better. Finished dimensions after fabrication were 7 in. by 16 in. by 14 ft. 2 in. Before installation, the glued, laminated stringers were creosoted with a 15.5-lb. per cu. ft. retention.

This project was on the Texas & Pacific, near Woodlawn, Tex., and was carried out during the war under the sponsorship of the War Production Board. The installation was made under the guidance of the Forest Products Laboratory, Madison, Wis., and the laboratory and the railway have maintained observation of this bridge since that

time. It is reported that the stringers have shown no evidence of delamination or deterioration.

In September, 1945, the Southern installed some laminated stringers, caps and posts in an open-deck trestle near Alexandria, Va. All lumber used was southern yellow pine, except for three plies of 3/4-in. red oak on the bottom and top of each cap. All members were treated by the Rueping process, after gluing, to an average retention of 7.76 lb. per cu. ft. of 80-20 creosote-coal tar solution. The members are inspected regularly and the last inspection showed them all to be in good condition. Other railroads that are testing laminated bridge members include the Atlantic Coast Line, the Chesapeake & Ohio, the Spokane, Portland & Seattle, and the Southern Pacific.

Lumber

The grades of lumber used in glued, laminated bridge members should be those required for the stresses used in design. The grade in the middle three-fifths of the depth of a beam may be one grade lower than in the upper and lower fifths, but should be free from warp, which would prevent uniform spreading of the glue and the surfaces of adjacent laminations from being brought into close contact. The material may be either flat grain or edge grain, but preferably all flat grain or all edge grain. If desired, the bearing surfaces may be made from lumber with a greater cross grain compressive strength than the innermost section. The bearing surfaces should be of a sufficient number of plies to produce a thickness of three to four inches. For economy, the individual plies of a laminated member should not be less than three quarters of an inch thick, and they should not be more than two inches thick. Two inches is the maximum practical thickness for curing, seasoning and preparing for gluing. The thinner plies result in an increased number of pieces to be machined and more glue lines, both of which will materially increase the cost. In narrow built-up members, the width of each lamination is usually the full width of the member, in a single piece. In wider members, the width of a lamination may be made up to two or more pieces, edge glued. Random widths, 4 in. and wider, may be used. For good appearance, top and bottom laminations should be of single-width pieces, or of strips glued together edgewise.

Longitudinal joints may be scarfed or butted, except that there should be no butted end joints in the surface laminations on either the tension or compression faces. Scarfed joints should be scarfed at a slope of not more than 1 in 12 except that the slope of the scarf need not be less than the slope of the grade of the lumber at the joint. The slope of the scarf should be free from knots or pitch-pockets. The scarfed ends should be completed and set, and smoothed to a uniform thickness with rest of piece before assembly into the member, unless means are used to secure the scarfed ends firmly in place during gluing. Scarfed end joints in corresponding laminations near compression and tension faces should be staggered longitudinally—center to center of joints—by at least 24 times the thickness of a single lamination. Butted end joints in adjacent laminations near compression and tension faces should be staggered by at least 40 times the thickness of a lamination. There should be no more than one joint in any three adjacent laminations in any longitudinal section equal in length to 24 times the thickness of the stock.

Machining Lumber for Gluing

Wood surfaces that are to be glued must be smooth and true, and machining must be done just before gluing to prevent distortion of the surfaces. Surfaces made by a saw are usually rougher than those made by planers, jointers and other machines equipped with cutter heads. However, recent perfection of saws for this purpose has made it possible to edge glue sawed joints more extensively thereby effecting a saving in labor and material. Machine marks, chipped or loosened grain, and other surface irregularities are objectionable. To produce satisfactory results, the maximum variation in thickness in any individual lamination should be restricted to 0.01 in., with every effort toward a 0.005-in. tolerance.

The glue used must be moisture-proof and not affected by the preservative treatment. Such glues include resorcinols, phenols and resorcinol - phenol blends. The time between mixing and using, and between spreading the glue and the application of pressure, varies with the glue and conditions of its use. Manufacturer's directions should be followed. The glue should be spread at a rate of 45 to 65 lb. per 1,000 sq. ft. on all faces which are to be glued together, including the inner faces of the outer laminations.

Double spreading of each lamination, except the outer ones, insures the wetting of all wood surfaces to be glued.

Moisture Content

The moisture content of the wood should be between 8 per cent and 15 per cent for the best results. Generally, 10 per cent to 12 per cent is preferable. The temperature of the glue and gluing room should be in accord with the directions issued by the manufacturer.

Uniformity of pressure is essential in the gluing process. Clamps should bear on a caulboard, or pressure-distributing board or plank, of sufficient thickness to distribute the pressure uniformly. With 3/4-in. cauls, a clamp spacing of 9 in. has been found to produce adequately glued joints. Smoothness of surface and freedom from warping and cupping are of the utmost importance to a good glue line. Pressure is required largely to make the contact. With a completely true and even surface, comparatively little pressure would be required, but pressure heavy enough to flatten out a cupped surface would require pressure varying in intensity over the surface, with a resultant glue line of variable quality. Generally, a pressure of 150 to 200 lb. per sq. in. is desirable and sufficient to insure a good joint. Ordinarily, a glued member can be handled after 24 hrs. and will carry its calculated load after a week or ten days. These provisions should be specified, however, for each particular case.

After curing, all members should be planed to the specified size and cut to the specified length. If desired, arrangements can be made with the manufacturer to pre-bore and pre-frame the members according to the railroad's plans and specifications. This may be a desirable procedure before the members are treated.

Strength

The properties of parallel-grain construction in glued, laminated members are essentially the same as those of solid wood, but laminated members, if well constructed, are usually more uniform in strength properties and less apt to change shape with variations in moisture content. One of the advantages of laminating is that the type and position of defects can be controlled. Laminated construction also offers the advantages that high-grade, strong material may be so placed in a member that its high strength can be more effectively utilized, while low-grade, weak material may be so placed that its low strength is not deleterious. To date the practice has been to eliminate large holes, knots, dote, wane, and similar defects by cross-cutting or ripping. Laminating, of course, cannot make non-durable species durable, but the non-durable or weak pieces can be eliminated. Tests on laminated bridge members have shown that the same strength can be obtained as in solid members.

Treatment

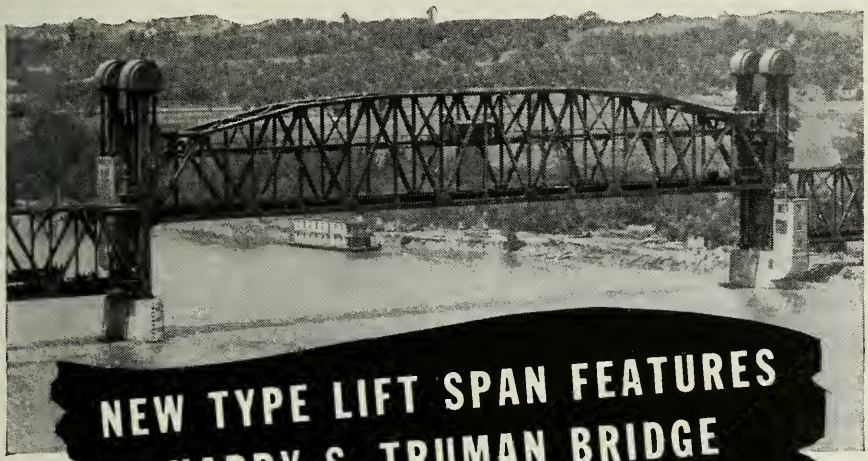
Tests have indicated that, with certain modifications in the curing process, lumber treated with salts or creosote can be glued with many of the highly water-resistant resins. However, where heavy retentions of oily preservatives have been used, definite interference with subsequent gluing has been noted. Consequently, modifications of treatments may be necessary when the lumber is intended for laminating after it is treated. The problem of treating after gluing has been fairly well met and solved. Many glued-up members have been successfully pressure treated when good waterproof glues are used, such as, resorcinols phenols and resorcinol blends. The compatibility of glue and kind of treatment with regard to acidity and alkalinity must be known. Not all glues and preservatives are compatible; the only way to find out which goes with which is to run tests. Fortunately, many such tests have been run already and the results may be obtained from glue manufacturing companies, treating companies and government laboratories. Before either treating lumber which is to be glued, or gluing lumber which is to be treated, the glue manufacturer, treating plant and Forest Products Laboratory should be consulted as to the proper procedure.

Cost

The number of laminated members in use in railroad bridges is too limited to permit full determination of their costs compared with solid timbers. In general, the initial cost per M. feet of laminated timbers will be greater than the cost of solid items, especially in the smaller sizes which are relatively cheap in solid form. This is because the raw material itself is the chief element of cost.

The lumber used for laminating must be machined before gluing and raw material is lost in the operation. Further-

THE 1,600-TON, 420-foot long lift span in its raised position provides a channel width of 400 feet and a vertical clearance above low water of 70 feet for navigation. The bridge consists of three 250-ft. through truss spans, one 420-ft. through truss vertical lift span, 18 deck plate girder spans of 78 feet and one plate girder span of 45 feet. It was designed and the construction supervised by Howard, Needles, Tammen & Bergendoff, consulting engineers.



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more, the cost of a specialized plant and equipment, and of the glue, must be added, and only a lesser cost of rough lumber can offset these added manufacturing costs. Although initial costs on the basis of footage will usually be higher for laminated timbers, true comparative costs can be appraised only in the light of long-run installation and maintenance costs, and total service life.

The greater dimensional stability of laminated timbers and their great resistance to splitting and checking mean less spoilage before installation and longer service life, with reduced maintenance and replacement costs. Relative costs will be further affected by overall size. Costs per M. feet of laminated timbers will be more or less constant, regardless of size. Solid timbers of large size, on the other hand, will be more costly per M. feet than will smaller sizes.

Mill-run lumber of random sizes, lengths and grades can be purchased at a much lower cost per M. feet than where the sizes, lengths and grades are specified. This lumber can then be sorted and graded, and only that meeting the required specifications used for laminated bridge members. The remainder can be used either as solid member or laminated members for other railroad purposes. This feature, alone, will have a greater tendency to reduce the cost of laminated bridge members to one comparable to solid members than any or all other factors combined.

The necessity for bridge renewals in most instances is spot deterioration. A large percentage of the salvaged lumber could be re-sawn, culled and machined for building laminated bridge members. Much of the timber would be of a better grade than can now be obtained, and would be available at a low cost compared with new material.

Advantages

Large solid timbers for use in railroad bridges are becoming more difficult to procure each year. They contain some visible defects and may contain hidden defects, all of which will impair their strength and usefulness. The scarcity of the large dimensional timbers may become so acute within a few years that the renewal of timber trestles with timber will be out of the question, and other material will have to be used entirely for this work. The railroads in this country have hundreds of miles of timber trestles with a remaining service life of 15 to 30 years. These trestles, along with hundreds of miles of older structures, will require an enormous amount of repair timber if they are to obtain their maximum economic life. It is doubtful whether after a few years sufficient repair material of solid lumber will be available at a cost that will not be prohibitive. Where then can repair material be obtained? The answer may lie largely in laminated members.

Good glue and good lumber are not all that is required to produce good laminated members. Good equipment, as well as a good technically-trained man for each laminating plant, are also essential for a high-class job. Otherwise, the product will not be a credit to the manufacturer and will not be reliable as a structural element.

The railroads are proceeding in the right direction by securing the services of the glue manufacturers, the lumber industries and wood products manufacturers, under the supervision of government laboratories. If they will continue under the workmanship and advice of these experts they will, in due time, be rewarded for their patience and perseverance. On the other hand, if they attempt to produce or have produced laminated members in a haphazard manner, the results may be bitterly disappointing.

Conclusion

It is not the intention that this report be construed as specifications, but rather as a brief description of the method of manufacture of glued, laminated members for railroad bridges. From information available, all installations to date have been for test purposes. Sufficient data is available from laboratory tests, however, to prove that laminated members can be made with the desired strength and durability, and in sizes and lengths greater than is possible from solid timber. These members can be made of any species of timber or of a combination of species where the moisture coefficients of expansion are approximately the same.

The committee is indebted to a number of manufacturers and to the Forest Products Laboratory for much of the information contained on this report.

DISCUSSION

Chairman Mayfield augmented the report by stating that, since the printing

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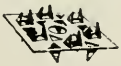

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of the report, he had learned that plies up to 3 in. thick could be successfully glued in lieu of the 2 in. maximum mentioned. President Campbell expressed the opinion that laminated members might be the answer to the present difficulty of getting large sizes of timber. Mr. Mayfield said that those interested could obtain the latest information on laminated members, as well as definite specifications, by contacting the Forest Products Laboratory, Madison, Wis.

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According to a 1944 engineering report, it was "only within the last five years that any serious deterioration has occurred, and only within the last two years that any considerable amount of renewals were necessary." It was stated that "the structure is still in fair condition and should not require any large expenditures for renewals or replacement for another 5 years." This will bring its age to 39. Even if the bridge had been totally replaced in 1940, so that only a *30-year* life had been realized, the yearly interest and amortization charges would have amounted, on a straight-line basis, to only $2100 a year . . . a saving of almost $50,000 for the period.

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	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

C. R. BOULTON

RAILROAD CONTRACTOR

BRIDGES + GRADING

STRUCTURES + MAINTENANCE

EQUIPMENT RENTAL

FUEL STORAGE

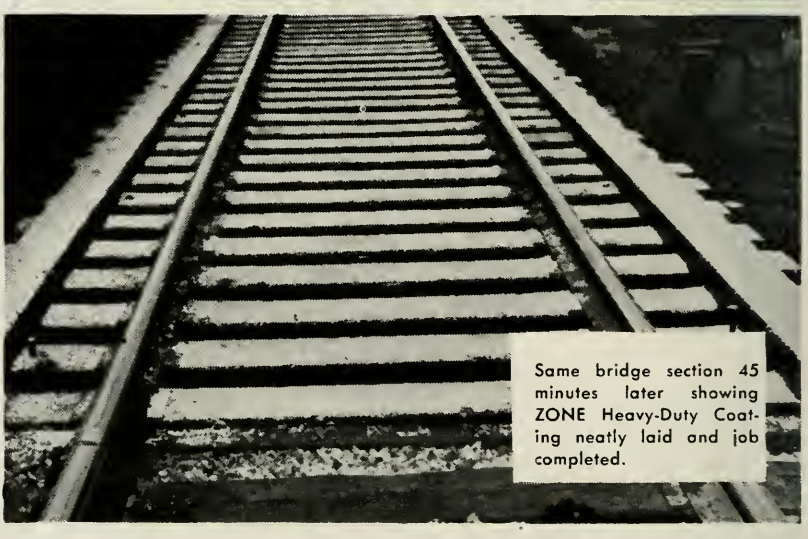
◆

Adams 8426 Adams 6636 Adams 6748

Columbus, Ohio

Prevent Bridge Fire Expense and Hazard...

ZONE Primer being applied under 60-pound pressure to ties and other exposed wood surfaces.



Same bridge section 45 minutes later showing ZONE Heavy-Duty Coating neatly laid and job completed.

adopt the proved

LIBBEY-ZONE

PROCESS

Brake shoe sparks, lighted cigarettes tossed by careless smokers, molten metal from overheated shoes, and from oil, coal and other fuel from locomotive boxes...all find a fire hungry target in unprotected wood surfaces where ordinary coatings have worn down or cracked open.

Leading railroads (names on request) are now restricting fires with the LIBBEY-ZONE Process using ZONE Heavy-Duty Coating...the scientific discovery that combines Canadian asbestos fibre with intensified asphalt gum to produce a long-lasting, economical, genuinely fire retardant surface for open-deck bridges and trestles.

ZONE Heavy-Duty Coating, when combined with the proper aggregate of crushed stone or gravel, expands with heat...yet does not melt; contracts with cold...yet does not flake. This protective coating is easily and quickly applied. Nationally distributed. Ask for our free booklet... and learn the advantages of

ZONE

HEAVY-DUTY COATING

The Zone Company

Div. of Southwestern Petroleum Co., Inc., Fort Worth, Texas

ZONE *HEAVY-DUTY COATING...for fire retardant protection.*

	1923-1924	1924-1925	1925-1926	1926-1927
President.....	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres....	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres....	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres....	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weiso
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President.....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres....	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres....	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres....	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres....	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

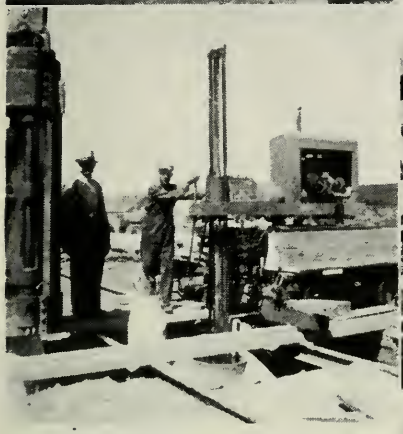
	1934-1935	1935-1936	1936-1937	1937-1938
President.....	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres....	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres....	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres....	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres....	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

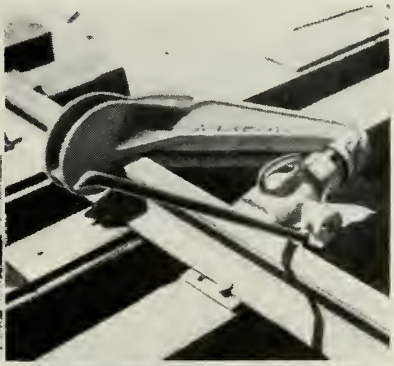
	1938-1939	1939-1940	1940-1941	1941-1942
President.....	Armstrong Chinn	A.E.Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres....	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres....	A.E.Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres....	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres....	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.....	C. A. Lichty	C. A. Lichty		
Secretary.....	.....	.....	F. O. Whiteman	A. G. Shaver
Treasurer.....	.....	.....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudie	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

BUDA *serving the railroads since 1881*

• **LEFT:** BUDA Power Track Drill for drilling bolt holes in "T" rail, girder rail or "I" beams, quickly and accurately. Light weight — powerful engine.

• **BELOW:** BUDA Rail Bender, bends heavy rail cold. One man bends 151 lb. rail easily with this handy tool.





• **ABOVE:** BUDA Earth Drill, highly efficient unit for all types of bridge and construction work. Model HBD shown, is pre-boring for piling on a typical bridge job.

• **RIGHT:** BUDA Klinch-Klaw Jack, ideal for pulling bolts and spikes from bridges and trestles.

WRITE FOR LITERATURE

BUDA

HARVEY *(Chicago Suburb)* ILLINOIS

	1942-1943	1943-1944	1944-1945	1945-1946
President.....	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.....	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.....	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.....	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.....	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary.....	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

	1946-1947			
President.....	F. G. Campbell			
1st V.-Pres.....	J. S. Hancock			
2nd V.-Pres.....	E. H. Barnhart			
3rd V.-Pres.....	W. F. Martens			
4th V.-Pres.....	W. A. Huckstep			
Secretary.....	Elise LaChance			
Treasurer.....	C. R. Knowles			
Directors	Guy E. Martin			
	B. R. Meyers			
	L. E. Peyser			
	H. M. Harlow			
	H. B. Christianson			
	F. R. Spofford			

†To November 1, 1942
‡To February 1, 1943

For Bridge Trouble...

DETZEL Restoration Service...

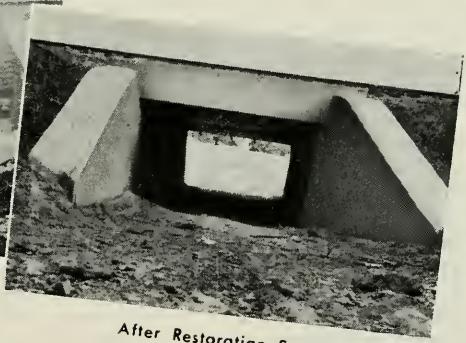
Pressure Grouting and "Guniting" of

Disintegrated concrete and masonry structures such as piers and abutments of railroad bridges, retaining walls, power plants, dams, steel encasements, and linings for tanks, reservoirs, tunnels, canals and ditches.

Condition of Bridge Wing Walls before starting work

After Restorotion Service

Note condition of disintegrated concrete Wing Wall at left



After Restoration Service

Let a Detzel Engineer Help You...

with Your Masonry Maintenance Problems

GEORGE E. DETZEL COMPANY

Pressure Grouting and Gunite Service

2303 GILBERT AVE. CINCINNATI 6, OHIO

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2. A member shall be a person in a responsible position in connection with railway bridge and building work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership a member must have belonged to the association for at least ten years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

*Amended October 16, 1941.

JACKSON

PORTABLE POWER PLANTS

(With Permanent Magnet Generators)

ELIMINATE LOST TIME . . . DELAYS

Model M-2 Portable Power Plant, 2.5 KVA capacity, is shown above. Other models 1.25 and 5 KVA capacities are also available.

JACKSON HYDRAULIC CONCRETE VIBRATOR

A gas-engine-driven independent unit of outstanding dependability. Ideal for B&B operations. Full details on request.

Never in the history of portable power plants has there been anything to compare in reliability and efficiency with the present JACKSON plants . . . a fact thoroughly demonstrated by thousands of users on railroads throughout the nation where they are daily employed to operate tampers as well as lights, saws, drills, vibrators and other power tools.

These plants are powered with husky Wisconsin engines and equipped with permanent magnet generators producing both single-phase and 3-phase 60 cycle, 110 volt AC. Generators have less than one-sixth the number of parts contained in the conventional generator — require no maintenance or adjustment and are free of all the small parts which usually are the source of generator trouble. Be sure to get the complete facts before you buy any portable power plant. Write, NOW!

JACKSON SOIL COMPACTOR

. . . shown in operation at the right, is a highly advantageous new tool for quickly and easily achieving maximum density in bridge approaches and similar fills. Propels itself. Firmly compacts 10 to 15 sq. ft. per minute of granular soil to a depth of 12 inches. Produces 95% maximum density in a single pass. Equally adaptable to coarse gravel and crushed rock. Write for details.

ELECTRIC TAMPER & EQUIPMENT CO.

LUDINGTON MICHIGAN

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9. Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers or selection of place for holding annual convention.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1. The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association but shall not have the power to render the association liable for any debt beyond the amount then in the treasury and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

*Amended October 16, 1941.

FABREEKA

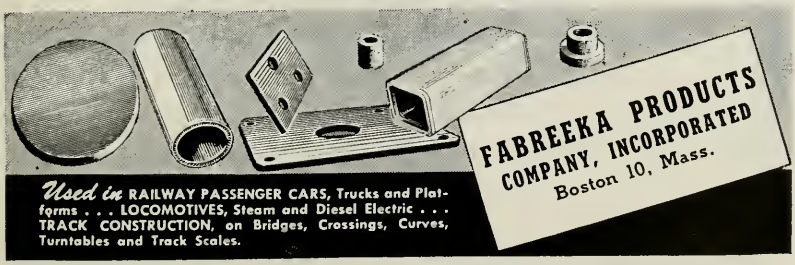
SAVES TRACK MAINTENANCE AND CONSTRUCTION COSTS

On Crossings, Crossovers
Severe Curves
Track Scales
Turntables

On Steel and Concrete
Decked Bridges
as well as
Viaducts

A FABREEKA Installation Beneath Crossings Crossovers and Switches

Increases the Life of the Manganese Points by Absorbing the Impacts of the Wheels.... Mechanical Wear of the Ties is reduced.... FABREEKA greatly prolongs the life of crossings and reduces maintenance costs. On curves FABREEKA reduces the frequency and expense of regauging track .... On steel and concrete decked bridges FABREEKA does away with the need for ties and reduces proportionately the depth of excavation and concrete work required to obtain the proper bridge clearance.


FABREEKA PRODUCTS
COMPANY, INCORPORATED
Boston 10, Mass.
Used in RAILWAY PASSENGER CARS, Trucks and Platforms . . . LOCOMOTIVES, Steam and Diesel Electric . . . TRACK CONSTRUCTION, on Bridges, Crossings, Curves, Turntables and Track Scales.

Section 2.† The president, four vice-presidents, secretary and treasurer shall hold office for one year and the directors for two years, three directors being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing but may receive others into affiliate membership. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING

2. The place of holding the next annual convention shall be selected by ballot at the annual meeting of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

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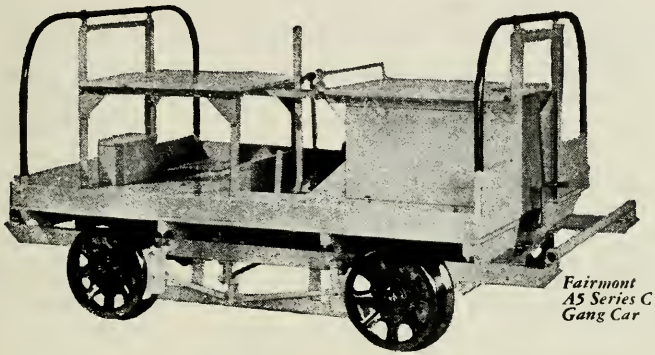
†Amended October 17, 1940.

*Article adopted 1922.

POWER

Combined with Four Speeds Forward or Reverse



Fairmont A5 Series C Gang Car

Moving men and materials quickly to and from bridge and building jobs is performed efficiently by Fairmont Gang Cars. Inspections are accelerated by Fairmont Inspection Cars. It is this Fairmont Performance on The Job that counts.

Fairmont

RAILWAY MOTORS, INC.

FAIRMONT, MINN., U.S.A.

FAIRMONT RAILWAY MOTORS, LTD., TORONTO, ONT., CANADA

DISTRICT SALES OFFICES

CHICAGO • NEW YORK • ST. LOUIS • WASHINGTON

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

DUES

5. The annual dues, for the fiscal year ending September 30, and payable in advance, shall be as follows:*

Members, $4.00; Associate Members, $3.00; Junior Members, $2.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees

*Amended October 16, 1941.
†Amended October 17, 1940.
‡Adopted October 17, 1940.

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SEATTLE 11, WASH.—Pioneer Sand & Gravel Co., Inc., 901 Fairview Ave., N.
TORONTO 10, ONT., CANADA—Asphalt Services Ltd., 366 Adelaide St., W.
FORT WILLIAM, ONT.—Northland Machinery Supply Co., Ltd., 203 Hardisty St.
WINNIPEG, MANITOBA—Northland Machinery Supply Co., Ltd.

who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Selection of place for next annual meeting.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise all discussions shall be governed by Robert's rules of order.

†Amended October 17, 1940.

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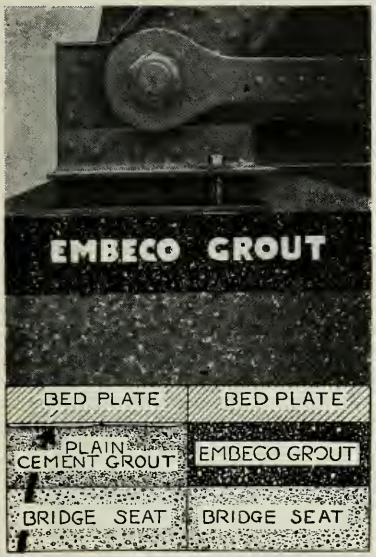

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DIRECTORY OF MEMBERS

as of March 1, 1948

(Figure after each name indicates year when member joined association.)

ACTIVE MEMBERS

H. C. Aaron, Supv. B. & B., W. M. R. R., Hagerstown, Md., (1935).
L. F. Abrams, Supv. W. S., I. C. R. R., Fort Dodge, Ia., (1947)
H. J. Aliberti, Asst. Supv. B. & B., Me. C. Ry., Portland, Me., (1947)
G. A. Allen, Br. Insp., C. & O. Ry., Clifton Forge, Va., (1940).
W. V. Allen, Asst. Supv B. & B., C. & O. Ry., Catlettsburg, Ky., (1946).
A. Anderson, Sp. Asst. Engr., N. Y. C. R. R., Chicago, (1947)
G. F. Anderson, For. B. & B., S. P. Co., Roseville, Calif., (1935)
J. L. Anderson, Sup. B. & B., Mo. Pac. R. R., Osawatomie, Kans., (1931)
W. L. Anderson, Off. Engr., C. & N. W. Ry., Chicago, (1940)
J. T. Andrews, Asst. Engr., B. & O. R. R., Baltimore, Md., (1947)
R. L. Antcliff, B. & B. Fore. C. & O R. R., Grand Ledge, Mich (1942)
C A. Appell, Mast. Carp., B. & O. R. R., Cumberland, Md., (1946).
W. F. Armstrong, Arch. Dftsmn., C. & N. W. Ry., Chicago, (1947)
L. K. Arnold, Div. Br. Insp., A. T. & S. F. Ry., San Bernardino, Calif., (1944).
T. J. Atkinson, Mast. Carp., Penn. R. R., Chicago, (1947)

J. H. Babbitt, Asst. Div. Eng., B. & O. R. R., Indianapolis, Ind., (1946).
R. C. Baker, B. & B. Supv. C & E. I. Ry., Danville, Ill., (1940)
M. L. Bardill, Asst. Engr., C. M. St. P. & P. R. R., Savannah, Ill., (1941).
E. H. Barnhart, Div. Engr., B. & O. R. R., Garrett, Ind., (1941).
H. L. Barr, Div. Engr., C & N. W. Ry., Boone, Ia., (1938)
G. J. Bass, Gen. For., B. B. & W. S., G. C. & S. F. Ry., Galveston, Tex., (1946).
W. A. Batey, (Retired) Constr. Engr., U P. R. R., Alhambra, Calif.
Y. C. Beam, Asst. Mast. Carp., S. A. L. Ry., Americus, Ga., (1945).
A. E. Bechtelheimer, (Retired) Engr. of Br., C. & N W. Ry., Chicago, (1920)
W. H. Begeman, B. & B. Supvr., Mo. Pac. R. R., Nevada, Mo., (1941).
J. G. Begley, Div. Engr., B. & O. R. R., Washington, Ind., (1946).
H. I. Benjamin, Vice-Chair. Sys., Com. on Ins., So. Pac. Ry., San Francisco, Cal., (1922).
H. F. Bennett, Mast. Carp., Erie R. R., Dunmore, Pa., (1934).
G. W. Benson, Supvr. B. & B., C. of G. Ry., Macon, Ga., (1940).
M. A. Beringer, Br. Insp., I. C. R. R., Chicago, (1929).
W. L. Biggerstaff, Asst. Supv. B. & B., C. N. S. & M. R. R., Racine, Wis., (1945).
C. E. Bingham, Mast. Carp., Reading Co., Tamaqua, Pa., (1948)
H. F. Bird, Supv. B. & B., N. Y. C. Sys., Syracuse, N. Y., (1937).
R. D. Bisbee, Gen. For., B. & B., and W. S., A. T. & S. F. Ry., Dodge City, Kans., (1947).
E. H. Blewer, Supv. Saf. Engr., N. Y. C. Sys., New York, (1937).
H. Bober, B. & B. Engr., G. M. & O. R. R., Mobile, Ala., (1947)
E. W. Bolmgren, Div. Engr., C. M. St. P. & P. R. R. Co., LaCrosse, Wis., (1937).
W. C. Borchert, Div. Engr., L. & A. Ry., Shreveport, La., (1942).
M. A. Bost, Asst. Engr., C. M. St. P. & P. R. R., Mason City, Iowa, (1935).
L. E. Bowers Supv. B. & B., C. of G. R. R., Opelika, Ala., (1947)
J. J. Brandimarte, Jr., Asst. Mast. Carp., Penn. R. R., Harrisburg, Pa.
R. H. Brandt, Mast. Carp., C. B. & Q. R. R., Galesburg, Ill., (1946).
I. C. Brewer, Div. Engr., C. M. St. P. & P. R. R., Milwaukee, Wis., (1947)
W. T. Brice, B. & B. Master, C. N. R., Regina, Sask., Can., (1946).
E. J. Brown, Engr. of Track, C. B. & Q. R. R., Chicago, (1947)
G. A. Brown, Gen. For. B. & B., A. T. & S. F. Ry., Wellington, Kans., (1946).
T. W. Brown, Chf. Water Chem., I. C. R. R., Chicago (1947)
R. J. Bruce, Asst. Engr., Mo.-Ill. R. R., Bonne Terre, Mo., (1946).
F. N. Budzenski, Asst. Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1938).
H. M. Buell, Bridge Insp. U. P. R. R., Omaha, Nebr., (1937).
W. H. Bunge, Asst. Engr., M. P. Lines, Houston, Tex., (1941).
E. E. Burch, Asst. Br. Engr., C. M. St. P. & P. Ry., Chicago (1945)
A. E. Burford, Gen. For. B. & B., I. C. R. R., Memphis, Tenn., (1947)
W. R. Burke, B. & B. Supv., I. C. R. R., Champaign, Ill., (1947)
A. L. Burleson, B. & B. Insp. (St. L.-S. F. Ry., Memphis, Tenn., (1947)
C. M. Burpee, V.-P. Simmons-Boardman Pub. Corp., New York, (1930).
C. D. Burrows, Mast. Carp., B. & O. R. R., Wilmington, Del., (1946).

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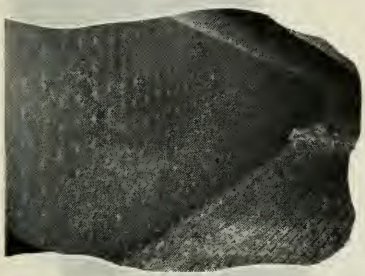

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W. J. Cable, Div. Engr., M. St. P. & S. S. M. R. R., Stevens Point, Wis., (1947)
W. W. Caines, Asst. Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1938).
F. G. Campbell, Ch. Engr., E. J. & E. Ry., Joliet, Ill., (1936).
J. P. Canty, Asst. to Engr. M. of W., B. & M. R. R., Boston, Mass., (1901).
J. G. Carlon, Asst. Supv. B. & B., C. & O. Ry., Russell, Ky., (1947)
M. D. Carothers, Asst. Ch. Engr., G. M. & O. R. R., Bloomington, Ill., (1938)
J. W. Carter, B. & B. Supv., Vir. Ry. Co., Roanoke, Va., (1947)
R. B. Carruthers, Br. Engr., T. & N. O. Ry., (S. P. Lines), Houston, Tex., (1946)
R. E. Caudle, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1921).
T. M. Cawthorn, Asst. B. & B. Supv., S. P. Co., Martinez, Calif., (1943).
P. C. Chamberlain, Asst. Engr., Erie R. R., Cleveland, Ohio. (1941)
A. B. Chaney, Asst. Engr. M. of W., Mo. Pac. Lines, St. Louis, Mo., (1947)
S. L. Chapin, Saf. Supv., So. Pac. Co., San Francisco, Calif., (1946).
A. B. Chapman, Br. Engr., C. M. St. P. & P. R. R., Chicago, (1938)
A. Chinn, Pres., Term. R. R. Assoc. of St. L., St. Louis, Mo., (1930).
H. B. Christiansen, Asst. to Ch. Engr., C. M. St. P. & P. Ry., Chicago, (1928).
L. Christiansen, B. & B. Fore., C. M. St. P. & P. Ry., Marion, Ia., (1928)
C. M. Chumley, Engr. M. of W., I. C. R. R., Chicago, (1947)
H. M. Church, Gen. Supv., B. & B., C. & O. R. R., Richmond, Va., (1939).
M. A. Clancy, Gen. Steel Fore., D. & H. R. R., Green Island, N. Y., (1942).
L. Clapper, Ch. Engr., D. M. & I. R. Ry., Duluth, Minn., (1919).
K. L. Clark, Div. Engr., C. M. St. P. & P. R. R., Chicago (1939)
W. P. Clark, Supv. B. & B., L. V. R. R., Wilkes-Barre, Pa., (1944).
E. J. Clopton, Div. Engr., B. & O. R. R., Cumberland, Md. (1944).
G. V. Coffey, Supv. B. & B., M. C. R. R., Jackson, Mich., (1941).
P. B. Collier, Supv. B. & B., M. P. R. R., St. Louis, Mo., (1938).
R. L. Collum, Mast. Carp., S. A. L. Ry., Jacksonville, Fla., (1941).
A. A. Colvin, Div. Engr., C. & N. W. Ry., Norfolk, Nebr., (1937).
J. Conley, Jr., Asst. Gen. Fire Insp., So. Pac. Co., San Francisco, Calif., (1947)
W. D. Conrad, Mast. Carp., Penn. R. R., Pittsburgh, Pa., (1947)
B. S. Converse, Div. Engr., C. & N. W. Ry., Sioux City, Ia., (1947)
D. W. Converse, Br. Engr., A. C. & Y. R. R., Akron, Ohio, (1940).
E. F. Cook, Water Serv. For., Mo. Pac. R. R., Little Rock, Ark., (1947)
B. Cooper, Br. Inspr. Mo. Pac. R. R.,DeQuincy. La., (1947)
A. E. Copeland, Mast. Carp., C. B. & Q. R. R., North LaCrosse, Wis., (1947)
S. T. Corey, Off. Engr. and Engr. Br., C. R. I. & P. Ry., Chicago, (1913).
C. O. Coverley, Sys. Arch., A. T. & S. F. Ry., Chicago, (1946).
L. A. Cowsert, W. Insp., B. & O. R. R., Dayton, Ohio, (1915).
R. P. Cox, Engr. of Power Plant, C. B. & Q. R. R., Chicago, (1947)
F. H. Cramer, Br. Engr., C. B. & Q. R. R., Chicago, (1927).
F. W. Creedle, Div. Eng., C. & N. W. Ry., Green Bay, Wis., (1942).
C. H. Crews, B. & B. Supv., I. C. R. R., Jackson, Tenn., (1947)
S. P. Critz, B. & B. Supv., I. C. R. R., McComb, Miss., (1946).
P. H. Croft, Div. Engr. I. C. R. R., Chicago. (1947)
M. Cronin, Asst. B. & B. Supv. So. Pac. Co., Tucson, Ariz., (1943)
W. E. Crounse, Supv. B. & B., D. & H. R. R., Plattsburg, N. Y., (1945).
J. W. Cummings, Supv. Wk. Eqpt., D. & H. R. R., Albany, N. Y., (1947)
H. D. Curie, Mast. Carp., B. & O. R. R., Garrett, Ind., (1942).

P. E. Dale, Supv. B. & B., N. Y. C. Sys., Indianapolis, Ind., 1947)
G. B. Davis, B. & B. Supv., N. Y. C. Sys., Columbus, Ohio, (1942)
H. E. Davis, B. & B. Supv., N. Y. C., Sys. Chicago, (1940).
C. E. Dawson, B. & B. Supv., St. L. S. W. Ry. Co. of Tex., Tyler, Tex., (1945).
E. G. Day, Ch. Engr., L. S. & I. R. R., Marquette, Mich., (1923).
R. A. M. Deal, B. & B. Supv., So. Ry. Richmond, Va., (1940)
R. DeArmond, Asst. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1938).
A. H. Deno, Supv., B. & B., C. & N. W. Ry., Green Bay, Wis., (1941).
L. J. Deno, Asst. Gen Br. Insp., C. & N. W. Ry., Chicago, (1947)
E. J. De Witt, Off. Engr., N. Y. O. & W. Ry., Middletown, N. Y., (1944).
H. M. Dick, Mast. Carp., Penn. R. R., Columbus, Ohio, (1942).
M. H. Dick, Man. Ed., Ry. Engr. & Mtce., Chicago, (1937).
A. G. Dorland, Asst. Engr., E. J. & E. Ry., Joliet, Ill., (1941).
J. L. Dougherty, Supv. B. & B., W. M. Ry., Cumberland, Md., (1944).
R. E. Dove, Man. Ed., Ry. Engr. & Mtce. Cycl., Chicago, (1934).
J. A. Doyle, B. & B. Master, D. & H. R. R., Corp., Carbondale, Pa., (1947)
J. V. Duchac, Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1927).
J. P. Dunnagan, Engr. of Br., So. Pac. Co., San Francisco, Calif., (1943).
F. Duresky, Jr., Asst. Supv. B. & B., C. & N. W. Ry., Milwaukee, Wis., (1942).

J. Ebbens, Supv., B. & M. B., C. & W. I. R. R., Chicago, (1947)
C. M. Eichenlaub, Res. Engr., S. D. & A. E. Ry. Co., San Diego, Cal., (1943).
C. Eisele, Asst. Engr., N. Y. C. Sys., Chicago, (1930).
E. M. Enger, B. & B. Supt., C. St. P. M. & O. Ry., St. Paul, Minn., (1947)
V. E. Engman, Ch. Carp., C. M. St. P. & P. R. R., Savanna, Ill., (1920).

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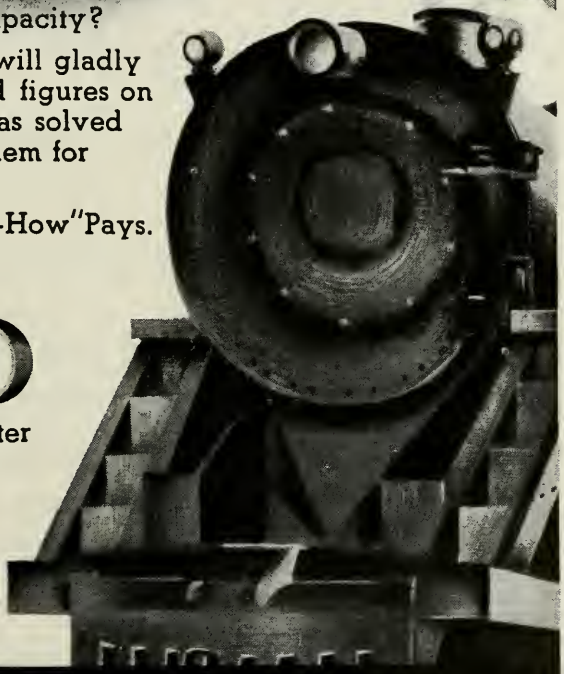

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C. C. Eubank, Asst. Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1938).
D. J. Evans, Div. Eng., B. & O. C. T. Ry., Chicago, (1946).
L. I. Evans, Instmn., C. M. St. P. & P. R. R., Savanna, Ill., (1937).
H. E. Ezzell, Asst. Scale Supv. Mo. Pac. Lines, San Antonio, Tex., (1947)

C. U. Faircloth, Br. Inspr., I.-G. N. R. R. Co. Palestine, Tex., (1947)
E. L. Farmer, Rdm., St. L. S. W. Ry., Lewisville, Ark., (1946).
L. M. Firehammer, Gen. Supv. B. & B., Ill. Term. R. R., Springfield, Ill., (1919).
T. J. Flessa, Supv. B. & B., M. P. R. R., Sedalia, Mo., (1941).
E. E. Foster, Asst. Engr., M. St. P. & S. S. M. R. R., Stevens Point, Wis., (1947)
R. L. Fox, Div. Engr., So Ry., Alexandria, Va., (1935)
W. H. Freeman, B. & B. Supv., C. G. W. Ry., Oelwein, Iowa, (1946).
C. G. Friets, Supv. B. & B., C. & N. W. Ry., Escanaba, Mich., (1938).
A. H. Frisbie, For. W. Ser., C. & N. W. Ry., Sioux City, Iowa, (1939).
L. M. Frost, Supv. B. & B., G. T. W. Ry., Battle Creek, Mich., (1938).
B. J. Furniss, B. & B. Supv., N. Y., N. H. & H. R. R., Hartford, Conn., (1946).

C. W. Gabrio, Br. Engr., Virginian Ry., Norfolk, Va., (1947)
J. Galbraith, B. & B. Supv., N. Y. C. R. R., New York, N. Y., (1947)
J. P. Gannon, Asst. Engr., M. St. P. & S. S. M. Ry., Stevens Point, Wis., (1947)
W. R. Ganser, Mast. Carp. Penn. R. R., Jersey City, N. J., (1931)
C. E. Garcelon, Supt. B. & B., B. & A. R. R., Houlton, Me., (1945).
L. D. Garis, Gen. Br. Inspr., C. & N. W. Ry., Chicago, (1930).
A. Gerske, Box 343. 1185 Hillcrest Blvd., Millbrae, Cal. (retired), (1938).
C. J. Geyer, Gen. Mgr. and Vice Pres., C. & O. Ry., Richmond, Va., (1928)
W. D. Gibson, Asst. Eng., C. B. & Q. R. R., Chicago, (1946).
C. F. Gilbert, B. & B. Supv., C. & O. Ry., Peru, Ind., (1944).
J. M. Giles, Asst. Eng. M. P. R. R., St. Louis, Mo., (1938).
W. G. Gillespie, Mast. Carp., B. & O. R. R., Grafton, W. Va., (1946).
A. D. Gillis, B. & B. Supv., N. Y., N. H. & H. R. R., Providence, R. I., (1923).
R. W. Gilmore, Gen. Br. Insp., B. & O. R. R., Cincinnati, Ohio, (1943).
F. M. Ginter, W. S. For., G. M. & O. Ry., Bloomington, Ill., (1939)
A. M. Glander, Ch. Carp., C. M. St. P. & P. Ry., Mason City, Iowa, (1936).
J. A. Goforth, Asst. Engh., Clinchfield R. R., Erwin, Tenn., (1944)
B. H. Goodwin, Supv. B. & B., So. Ry., Atlanta, Ga.
H. E. Graham, Asst. Supt. W. S., I. C. R. R., Chicago, (1946).
W. R. Graham, Asst. Supv. B. & B., C. & O. R. R., Covington, Ky., (1946).
E. Gram, B. & B. Supv., So. Pac. Co., Soda Springs, Calif., (1934).
H. P. Greene, Mast. Carp. Penn. R. R., Pittsburgh, Pa., (1947)
K. E. Grinnell, Rdm. and Supv. B. & B., N. & W. Ry., Norfolk, Va., (1946).
A. Guenther, Asst. Mast. Carp., C. B. & Q. R. R., Galesburg, Ill., (1947)
E. Gunderson, (retired), Supt. B. & B., C. St. P. M. & O. Ry., Altoona, Wis. (1927)
R. R. Gunderson, B. & B. Supv., So. Ry. Co., Valdosta, Ga., (1947)
B. W. Guppy, Engr. Str., B. & M. R. R., Boston, Mass., (1914).

E. H. Haase, B. & B. Supv., So. Pac. Co., Tucson, Ariz., (1943).
P. Haines, Asst. B. & B. Supv., P. M. Ry., Saginaw, Mich., (1943).
H. C. Halliday, B. & B. Master, Can. Nat'l Ry., Prince Rupert, B. C., Can. (1947)
A. A. Hampton, Asst. Supv. B. & B., Mo. Pac. Lines, De Quincy, La., (1947).
J. S. Hancock, Br. Engr., D. T. & I. R. R., Dearborn, Mich., (1916).
G. W. Hand, Asst. to Pres., C. & N. W. Ry., Chicago, (1909).
J. P. Hanley, Asst. Supt. W. S., I. C. R. R., Chicago, (1941).
A. H. Hansbury, Gen. For. B. & B.-W. S., A. T. & S. F. Ry., Las Vegas, N. M., (1946).
J. A. Hanson, B. & B. Supv., N. Y. C. Sys., Cincinnati, Ohio, (1947).
C. R. Harding, Pres., The Pullman Co., Chicago (1924)
H. M. Harlow, Asst. Gen. Supv. B. & B., C. & O. Ry., Richmond, Va., (1939).
W. C. Harman, Supv. B. & B., So. Pac. Co., San Francisco, Calif., (1911).
M. J. Harp, Supv. B. & B., Mo. Pac. R. R., Poplar Bluff, Mo., (1938)
A. R. Harris, Asst. Engr. of Br., C. & N. W. Ry., Chicago, (1940).
G. F. Hartman, Asst. Supv. B. & B., C. & O. Ry., Columbus, Ohio, (1947)
M. S. Harwood, Asst. B. & B. Supv. So. Pac. Co., San Francisco, Calif., (1948)
E. M. Hastings, Ch. Eng., R. F. & P. R. R., Richmond, Va., (1940).
J. Hayes, Arch., Gr. No. Ry., St. Paul, Minn., (1942).
J. J. Healy, Asst. B. & B., Supv., B. & M. R. R., Boston, Mass., (1947)
J. E. Heck, Supv. B. & B., C. & O. Ry., Ashland, Ky., (1938)
R. L. Hecker, B. & B. Supv., C. & O. R. R., Saginaw, Mich., (1947)
H. Heizenbuttel, (retired) B. & B. Supv., C. & N. W. Ry., 808 S. 3rd St., Norfolk, Nebr., (1917)
R. D. Hellweg, Asst. Div. Engr., G. M. & O. Ry., Bloomington, Ill., (1947)
B. Henistad, Mast. Carp., Gr., Nor. Ry., Willmar, Minn., (1937).
H. R. Herrick, B. & B. Supv., So. Pac. Co., Tucson, Ariz. (1941)
G. C. Hill, Asst. Mast. Carp., P. R. R., Steubenville, Ohio, (1946).

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P. W. Hofstetter, Br. Insp., M. P. R. R., San Antonio, Tex., (1946).
V. V. Holmberg, Asst. Engr., C. & W. I. Ry., Chicago. (1942)
F. F. Hornig, Div. Engr., C. M. St. P. & P. R. R. Mason City, Iowa, (1947)
N. D. Howard, West. Ed., Railway Age, Chicago, (1926).
B. J. Howay, B. & B.-W.S., C & O. Ry., Grand Ledge, Mich., (1919)
A. C. Hoyt, B. & B. Engr., E. J. & E. R. R., Joliet, Ill., (1947)
V. T. Huckaby, Steel Br. Insp., M. K. T. R. R. Co., Hillsboro, Tex., (1947)
W. A. Huckstep, Gen. Bldg. Supv., M. P. R. R., St. Louis, Mo., (1941).
W. H. Huffman, Div. Engr., C. St. P. M. & O. Ry., St. Paul, Minn., (1941).
C. A. Hughes, Supt. B. & B., E. J. & E. Ry., Joliet, Ill., (1943).
F. G. Hull, B. & B. Supv., C. & O. Ry., St. Thomas, Ont., Can., (1947)
R. W. Humphreys, Div. Engr., Nor. Pac. Ry., Missoula, Mont., (1947)
G. R. Hunt, Architect, G. G. & S. F. Ry., Galveston, Tex., (1947)
H. A. Hunt, B. & B. Supv., T. & N. O. R. R. Co., Houston, Tex., (1946).
J. S. Huntoon, Asst. Engr., M. C. R. R., Detroit, Mich., (1915).
F. C. Huntsman, Asst. Eng., Wab. R. R., St. Louis, Mo., (1922).
F. W. Hutcheson, Asst. Supv. B. & B., C. & O. Ry., Newport News, Va., (1938).
W. A. Hutcheson, Supv. B. & B., C. & O. Ry., Clifton Forge, Va., (1939).
V. W. Hutchings, B. & B. Supv., S. P. Co., Bakersfield, Calif., (1941).
J. S. Hyatt, Ch. Engr., C. N. S. & M. Ry., Chicago, (1944).

J. A. Inmann, Gen. For. B. & B., St. L. S. F. Ry., Chaffee, Mo., (1947)
D. W. Isaacs, Mast. Carp., C. R. I. & P. Ry., Des Moines, Ia., (1947)
H. E. Jackman, Mast. Carp., B. & O. R. R., Chillicothe, Ohio, (1944).
C. E. Jacobson, Engr. B. & B., A. & W. P., W. of A., Ga. R. R., Atlanta, Ga., (1946).
H. W. Jenkins, Supv. B. & B., N. Y. N. H. & H. R. R., Boston, Mass., (1940).
W. J. Jerrow, Asst. Mast. Carp., G. N. Ry., Whitefish, Mont., (1946).
E. S. Joehnk, Asst. Eng. Con. & Maint., B. & O. C. T. R. R., Chicago, (1946).
A. C. Johnson, Supt. B. B., E. J. & E. Ry., Joliet, Ill., (1944)
B. O. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Chicago. (1931).
D. H. Johnson, Supv. B. & B., C. St. P. M. & O. Ry., St. Paul, Minn., (1940)
E. H. Johnson, Div. Engr., C. M. St. P. & P. R. R., Spokane, Wash., (1940).
H. G. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Ottumwa, Ia., (1930).
M. Johnson, Prin. Asst. Engr., I. C. R. R., Chicago, (1915).
R. W. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1922).
A. C. Jones, Supv. B. & B., So. Ry., Jasper, Ala., (1938).
E. B. Jones, Br. Insp., C. & O. Ry., Clifton Forge, Va., (1945).
J. A. Jorlett, Mast. Carp., Penna. R. R., Pittsburgh, Pa., (1946).

C. T. Kaier, Gen. Br. Insp., D. L. & W. R. R., Hoboken, N. J., (1937).
R. D. Kelly, Asst. Supt. B. & B., C. & N. W. Ry., Chicago, (1942).
W. G. Kemmerer, Asst. Engr. B. & B., Penna. R. R., New York, (1931).
W. V. Kerns, Supt. B. & B., C. & N. W. Ry., Mason City, Iowa, (1924).
D. P. Kinzel, Supv. Supv. B. & B., N. Y. C. Sys., Delmar, N. Y., (1921).
L. P. Kimball, Eng. Bldg., B. & O. R. R., Baltimore, Md., (1921).
T. R. Klingel, Asst. Prof., Engr. Dept., Univ. of Minn. Inst. of Tech., Minneapolis, Minn., (1943)
P. L. Koehler, Asst. Supt., C. & O. Ry., Peach Creek, W. Va., (1938).
M. E. Koenig, Asst. Supv., B. & B., C. & N. W. R. R., Boone, Ia., (1947)
W. B. Konkle, For. Carp., Reading Co., Milton, Pa., (1947)
A. S. Krefting, Prin. Asst. Eng., M. St. P. & S. S. M. Ry., Minneapolis, Minn. (1935).
H. H. Kruse, Ch. Carp., C. M St. P. & P. R. R., Mitchell, S. Dak. (1947).
P. F. Kuchera, Mast. Carp., C. B. & Q. R. R., Omaha, Nebr., (1947)
S. E. Kvenberg, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1932).

J. J. LaBat, B. & B. Supv., Mo. Pac. Ry., Wichita, Kans., (1937)
W. S. Lacher, Secy., Am. Ry. Engr. Assoc., Chicago, (1922).
C. W. Laird, Scale Supt., Mo. Pac. Lines, Houston, Tex., (1947)
L. R. Lamport, Asst. to Cr. Engr., C. & N. W. Ry., Chicago, (1935)
W. Lampson, Supv., B. & B., Maine Cent. R. R., Portland, Me., (1930).
J. S. Langston, Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark., (1947)
K. Larson, Supv. B. & B., C. & N. W. Ry., Sioux City, Iowa, (1917)
F. J. A. Leinweber, B. & B. Mast., Can. Nat'l Rys., St. Thomas, Ont., Can., (1947).
J. A. Lewis, Supv. B. & B., N. Y. C. Sys., Buffalo, N. Y., (1948).
F. W. Lichtenberger, Jr., Asst. Mast. Carp., Erie R. R., Paterson, N. J., (1945).
H. J. Lieser, Trk. Supv., Belt Ry. of Chicago, (1948).
J. H. Lindsay, Div. Eng., B. & O. R. R., Grafton, W. Va., (1946).
H. M. Link, Asst. Supv. B. & B., C. & N. W. Ry., Winona, Minn., (1940).
G. A. Linn, Supt. B. & B., C. & N. W. Ry., Boone, Iowa, (1940).

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E. M. Loebs, Asst. Eng., B. & B., C. & I. M. R. R., Springfield, Ill. (1946).
G. P. Lokotzke, Supv. B. & B., E. J. & E. Ry., Gary, Ind., (1947)
H. T. Lord, B. & B. Master, Can. Pac. Ry., Kenora, Ont., (1920)
R. P. Luck, Dftsman, C. & N. W. Ry., Chicago, (1920).
C. V. Lund, Asst. Eng., C. M. St. P. & P. R. R., Chicago, (1947).
L. E. Lyon, Div. Engr., So. Pac. Co., El Paso, Tex., (1947)
W. H. Lytle, Supv. B. & B., N. Y. C. Sys. Anderson, Ind., (1945).

H. C. Madson, Dftsman, C. & N. W. Ry., Chicago, (1940).
W. J. Mahoney, Supv. B. & B., L. & N. R. R., Louisville, Ky., (1946).
C. D. Malloy, B. & B. For., M. P. Ry., Piedmont, Mo., (1940).
B. F. Manley, Supv. B. & B., Pac. Elec. Ry. Co., Los Angeles, Cal., (1943).
D. A. Manning, Supt. B. & B., C. & N. W. R. R., Chicago, (1939).
W. J. H. Manning, (retired), Div. Engr., D. & H. R. R., Plattsburgh, N. Y. (1923)
L. S. Marriott, Gen. Bldg., Inspr., I. C. R. R., Chicago, (1947)
W. F. Martens, Gen. Frmn., B. & B., A. T. & S. F. Ry., San Bernardino, Calif., (1924).
G. E. Martin, Supt. W. S., I. C. R. R., Chicago, (1942).
J. U. Martin, Mast. Carp., S. A. L. R. R., Raleigh, N. C., (1946).
T. J. Martin, Gen. Mast. Carp., G. N. Ry., Seattle, Wash., (1940).
W. J. Martindale, B. & B. Mast., T. H. & B Ry., Hamilton, Ont., Can., (1934).
E. L. Mason, B. & B. Supv., Mo. Pac. Ry. Co., Kingsville, Tex., (1946).
H. M. Mason, Gen. Frmn. B. & B., A. T. & S. F. Ry., Pueblo, Colo., (1936).
F. H. Masters, Spec. Eng., E. J. & E. R. R., Joliet, Ill., (1920).
W. G. Mateer, Pur. Agent, E. J. & E. Ry., Chicago, (1944).
R. C. Mathis, Br. Inspr., I. C. R. R., Memphis, Tenn., (1947)
A. N. Matthews, Gen. For. B. & B. and W. S. St. L. S. F. Ry., Fort Scott, Kans. (1947)
L. Maytield, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1944).
J. W. N. Mays, Asst. Mast. Carp., Penn. R. R., Steubenville, Ohio, (1947)
J. McCaffery, Asst. Gen. Br. Insp., Sou. Pac. Co., San Francisco, Cal., (1922).
J. F. McCay, B. & B. Insp. N. Y. C. Sys. Chicago (1945).
C. A. McColgin. Mast. Carp., C. B. & Q. R. R., Hannibal, Mo., (1946).
W. McCollum, Sup. W. S., I. C. R. R., Paducah, Ky., (1944).
A. A. McDermott, B. & B. Supv., So. Pac. Co., Dunsmuir, Calif., (1945).
J. W. McDonald, Gen. For. B. & B. W. S., St. L. S. F. Ry., Springfield, Mo., (1947).
O. R. McIlhenny, Asst. Supt., T. C. & I. R. R., Ensley, Ala., (1916).
E. R. McKee, Asst. Div. Engr., B. & O. R. R. Co., Washington, Ind., (1947)
P. E. McNally, Sr., Asst. B. & B. Supv., So. Pac. Co., Ogden, Utah, (1948).
J. W. McReynolds (Div. Engr., C. M. St. P. & P. R. R., Ottumwa, Ia., (1947)
W. R. Meeks, B. & B. Supv., M. P. R. R., Falls City, Nebr., (1942).
B. W. Merrill, Supv. B. & B., N. Y. C. & St. L. R. R., Conneaut, Ohio, (1936).
P. B. Merwin, Asst. Eng., C. & N. W. Ry., Chicago, (1927).
B. R. Meyers, Asst. Ch. Engr., C. & N. W. Ry., Chicago, (1930).
H. E. Michael, Assoc. Ed. Railway Age and Ry. Engr. & Mtce. Chicago, (1947)
C. E. Miller, Asst. Engr. Mtce., C. & N. W. Ry. Co., Chicago, (1916).
J. O. Miller, Mast. Carp., B. & O. Ry., Flora, Ill., (1945).
F. M. Misch, Gen. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1937).
E. W. Moore, Mast. Carp., C. B. & Q. R. R., Centerville, Iowa, (1942).
I. A. Moore, Sr., Asst. Engr., C. & E. I. R. R., Danville, Ill., (1937).
J. D. Moore, Jr., Asst. Mast. Carp., Penn. R. R. Philadelphia, Pa., (1947)
L. R. Morgan, Fire Prev. Eng., N. Y. C. R. R., Detroit, Mich., (1937).
E. N Morin, B. & B. Mast., C. P. R., Farnham, Que., (1946).
W. O. Morris, Supv. W. S., I. C. R. R., Waterloo, Ia., (1947)
R. H. Morrison, Prin. Asst. Engr., B. & A. Ry., Houlton, Me., (1941).
C. H. Mottier, V.-P. & Ch. Eng., I. C. Sys., Chicago, (1942).
C. A. Murtaugh, Mast. Carp., Erie R. R., Marion, Ohio (1939)

E. I. Nelson, W. S. For., Mo. Pac. Ry., Nevada, Mo., (1948)
E. R. Nelson, Supv. B. & B., C. & N. W. Ry., Huron, S. D., (1937).
W. O. Nelson, Reg. Br. Insp., B. & O. R. R., Baltimore, Md., (1947)
J. E. Nielsen, Asst. Engr. of Bldgs., C. B. & Q. R. R., Chicago. (1947)
M. S. Norris, Asst. Eng., B. & O. R. R., Pittsburgh, Pa., (1946).
R. L. Norton, Mast. Carp., S. A. L. R. R., Savannah, Ga., (1947).
C. O. Nuckolls, Ch. Engr. S. S. Ry. Co., Sand Springs, Okla., (1944).
W. Nuetzel, Asst. Engr. Brdgs., B. & O. C. T. R. R., Chicago, (1945).

W. C. Oest, Prin. Asst. Engr., Ft. W & D. C. Ry. (Burlington), Ft. Worth, Tex., (1947)
G. Olson, Asst. Supt. B. & B., C. & N. W. Ry., Huron, S. D., (1944).
T. D. Osbourne, Asst. B. & B. Supv., So. Pac. Co., Alhambra, Calif., (1943).

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E. L. Parrish, B. & B. Supv., I. C. R. R., Vicksburg, Miss., (1947)
E. Patenaude, B. & B. Mast., C. P. R., Sudbury, Ont., Can., (1930).
R. E. Paulson, Ch. Dftsman, C. M. St. P. & P. R. R., Chicago, (1945).
J. R. Penhallegon, Asst. B. & B. Supt., C. & N. W. Ry., Chicago, (1940)
L. R. Pennington, B. & B. Supv., C. & N. W. R. R., Chadron, Nebr., (1938).
M. E. Peppin, Asst. Engr., A. T. & S. F. Ry., Glendale, Calif., (1947)
W. C. Peters, Mast. Carp., B. & O. C. T. R. R. Co., Chicago, (1946).
N. E. Peterson, Engr. M. of W., C. & I. M. Ry., Springfield, Ill., (1938)
L. E. Peyser, Architect, So. Pac. Co., San Francisco, Calif., (1937)
A. Pfeiffer, Asst. B. & B. Supv., So. Pac. Co., Stockton, Calif., (1939).
B. C. Phillips, Mast. Carp., C. B. & Q. R. R., Alliance, Nebr., (1947)
W. J. Phillips, Asst. Gen. Br. Insp., So. Pac. Co., Berkeley, Calif., (1925).
C. Piccone, Engr. of Br., Nat. Rys. of Mexico, Mexico City. D. F., Mex., (1923).
T. W. Pinard, B. & B. Engr., Penn. R. R., New York. (1920).
N. F. Podas, Ch. Engr., Minn. Trans. Co. & St. Paul Un. Depot Co., St. Paul, Minn., (1937).
L. F. Pohl, Asst. Engr., C. M St. P. & P. Ry., Chicago, (1937)
H. L. Porter, Asst. B. & B. Supv., So. Pac. Co., Ogden. Utah, (1945).
H. M. Potts, Mast. Carp., B. & O. R. R., Wheeling. W. Va., (1946).
W. G. Powrie, Engr. M. of W., C. M. St. P. & P. R. R., Chicago, (1939).
R. G. Preston, Asst. Engr., Penn. R. R., Chicago, (1947)
W. H. Pryor, Gen. For. B. & B. and M. S., St. L.-S. F. Ry., Memphis, Tenn., (1946)

W. H. Rainey, Asst. B. & B. Supv., T. & N. O. R. R. (So. Pac. Co.), (1947)
L. F. Rapier, Supv. B. & B., G. M. & O. R. R., Chicago, (1946)
G. W. Rear, Jr., Asst. Gen. Fire Insp., Sou. Pac. Co., San Francisco, Calif., (1939).
A. N. Reece, Asst. to Pres., K. C. S. Ry., Kansas City, Mo., (1922).
A. D. Reed, Mast. Carp., C. B. & Q. R. R., McCook, Nebr., (1945).
F. A. Reed, Supv. B. & B., I. C. R. R., Clinton, Ill., (1947)
L. J. Reed, Asst. Gen. Br. Insp., So. Pac. Co., San Francisco, Cal., (1945).
A. G. Reese, Dist. Maint. Engr., C. B. & Q. R. R., Galesburg, Ill., (1947)
O. C. Rhoades, Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago, (1947)
C. A. J. Richards, Mast. Carp., Penna. R. R., Grand Rapids, Mich., (1924).
A. O. Ridgway, Eng. Conslt., D. & R. G. W. R. R., Denver, Colo., (1910).
H. T. Rights, Asst. Br. Engr., L. V. R. R., Bethlehem, Pa., (retired), (1927).
D. T. Rintoul, Gen. Br. Insp., So. Pac. Co., San Francisco, Calif., (1910).
N. R. Robinson, B. & B. Supv., So. Pac. Co., Sacramento, Calif., (1934).
T. S. Ronan, Supv. B. & B., C. & N. W. Ry., Pierre, S. Dak., (1947)
W. R. Roof, Br. Engr., C. G. W. R. R., Chicago, (1927).
H. W. Routenberg, Mast. Carp., B. & O. R. R., Baltimore, Md., (1946).
J. W. Rowland, Mast. Carp., Penna. R. R., Jamaica, N. Y., (1937).
R. T. Rumbold, B. & B. Supv., So. Ry., Greensboro, N. C., (1947)
C. E. Russell, Supv. W. S., Ill. Cent. R. R., Chicago, (1944).
G. M. Ryan, B. & B. Supv., N. Y., N. H. & H. R. R., Boston, Mass., (1947)

J. R. Safley, Asst. B. & B. Supv., So. Pac. Co., Dunsmuir, Calif., (1945)
J. M. Salmon, Jr., Asst. Br. Insp., L. & N. R. R., Louisville, Ky., (1938).
T. D. Saunders, Ch. Engr., Northland Ry., North Bay, Ont., Can., (1930).
L. H. Schaeperklaus, Asst. Eng., N. Y. C. R. R., Cincinnati, Ohio, (1943).
F. F. Schilt, Asst. Div. Engr., B. & O. R. R., Grafton, W. Va., (1946).
E. R. Schalaf, Asst. Supt. W. S., I. C. R. R., Chicago, (1947)
E. W. Scott, Asst. Div. Eng. Erie R. R. Co., Buffalo, N. Y., (1945).
C. Sedmiradsky, Supv. B. & B., C. St. P. M. & O. Ry., Spooner, Wis., (1914).
L. L. Seley, Mast. Carp., C. B. & Q. R. R., Hannibal, Mo., (1947).
J. F. Shanklin, Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago. (1947).
C. J. Shapland, Asst. Engr., B. & B., C. V. Ry., (Can. Nat'l. Rys.), St. Albans, Vt., (1945)
T. J. Sheehy, Gen. Plumber For., D. & H. R. R., Plattsburg. N. Y., (1928).
S. H. Shepley, Supv. Track. E. J. & E. Ry., Joliet, Ill., (1845)
F. Shobert, Sys. Steel Const. Frm., So. Pac. Co., Oakland, Cal., (1918).
J. R. Showalter, Br. Engr., M. P. R. R., St. Louis, Mo., (1942).
F. A. Siegfried, For. Carp. B. & B., Reading Co., Reading, Pa., (1947)
P. X. Simpson, Supv B. & B., Nor. Pac. Ry., Tacoma, Wash., (1947)
C. C. Sims, Supv. B. & B., C. & O. Ry.,Hinton, W. Va., (1947)
E. W. Singer, Supv. B. & B., N. Y. C. & St. L. R. R., Fort Wayne, Ind., (1923).
A. A. Sirel, Br. Asst., A. A. R., Chicago. (1940).
G. L. Sitton, Asst. Ch. Engr., M. of W., So. Ry. Sys., Washington, D. C., (1920)
H. E. Skinner, Supv. S. & W. Equip., E. J. & E. Ry., Joliet, Ill., (1944).
F. M. Sloane, Div. Eng., C. M. St. P. & P. R. R. Co., Milwaukee, Wis., (1927).
B. Smart, Trk. Supv., D. T. & I. R. R., Dearborn. Mich., (1945).
C. A. Smith, Supv. B. & B., C. R. & I.-I. H. B. R. R., Hammond, Ind., (1946)
C. E. Smith, Vice-Pres., N. Y. N. H. & H. R. R., New Haven. Conn., (1911).

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J. Smith, Asst. B. & B. Supv., So. Pac. Co., Sacramento, Cal., (1943).
L. C. Smith, Div. Engr., C. & N. W. Ry., Madison, Wis., (1942)
R. H. Snow, Gen. For., Maine Cent. R. R., Waterville, Maine, (1947)
J. W. Snyder, Supv. B. & B., N. Y. O. & W. Ry., Middletown, N. Y., (1945).
R. H. Snyder, Asst. Arch., So. Ry. Co., Cincinnati, Ohio, (1946).
D. Speaker, Mast. Carp., Penna. R. R., Steubenville, Ohio, (1928).
W. A. Spell, Engr. M. of W., A. C. L. Ry., Atlanta, Ga., (1941).
F. R. Spofford, Asst. Div. Engr., B. & M. R. R., Dover, N. H. (1940).
G. L. Staley, Br. Engr., M.-K.-T. R. R., St. Louis, Mo., (1946).
W. B. Starnes, Br. Inspr., Mo. Pac. Lines, Kingsville, Tex., (1947)
G. T. Steidel, Br. Eng., L. & N. E. R. R., Bethlehem, Pa., (1946).
B. M. Stephens, Arch. Engr., T. & N. O. R. R., Houston, Tex., (1946).
O. W. Stephens, Asst. Eng. Str., D. & H. R. R., Albany, N. Y., (1941).
I. F. Stern, Con. Engr., Chicago, (1943).
F. J. Stewart, Ch. Engr., Port Everglades Belt Lines Ry., Port Everglades (Ft. Lauderdale), Fla., (1944).
T. H. Strate, (retired), Div. Engr., C. M. St. P. & P. Ry., Chicago, (1918).
J. A. Strouss, Asst. B. & B. Supv., Sou. Pac. Co., Sacramento, Calif., (1934).
W. J. Strout, Ch. Engr., B. & A. R. R., Houlton, Me., (1932).
J. W. Stutzman, For. Carp., Reading Co., Reading, Pa., (1947)
L. Sullivan, Supv. B. & B., Ill. Cent. R. R., Carbondale, Ill., (1944).
G. L. Summers, W. S. Rep., Mo. Pac. R. R., Bismarck, Mo., (1940).
W. A. Sweet, Gen. Frm. B. & B., A. T. & S. F. Ry., Newton, Kans., (1928).

C. R. Taggart, Supv. B. & B., N. Y. C. Sys., Indianapolis, Ind., 1935).
E. E. Tanner, Gen. Supv., B. & B., N. Y. C. Sys., Albany, N. Y., (1938).
E. R. Tattershall, Supt. Mtce. Eqpt., N. Y. C., Sys., New York, N. Y., (1913).
R. S. Templin, For. Carp., Reading Co., Pottsville, Pa., (1947)
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F. W. Thompson, Ch. Engr., C. R. I. & P. Ry., Chicago, (1946).
S. R. Thurman, Supv. B. & B., Mo. Pac. R. R., Nevada, Mo., (1943).
A. C. Tinsley, Supv. B. & B., N. & W. Ry., Crewe, Va., (1945).
A. G. Todd, Asst. Div. Engr., B. & O. R. R., Garrett, Ind., (1946).
D. C. Todd, Mast. Carp., Penna. R. R., Pittsburgh, Pa., (1942).
E. B. Tourtelotte, Supv. B. & B., B. & M. R. R., Greenfield, Mass., (1947).
D. E. Tracy, Asst. B. & B. Supv., So. Pac. Co., Bakersfield, Calif., (1946).
J. D. Trulove, Asst. B. & B. Supv., So. Pac. Co., Sparks, Nev., (1945)
N. R. Tucker, Asst. Div. Engr., T. & N. O. R. R., (So. Pac. Lines) Lafayette, La., (1939)
H. C. Tunison, Asst. Engr. M. of W., L. & N. E. R. R., Bethlehem, Pa., (1946).
A. E. Tupper, B. & B. For., So. Pac. Co., Stockton, Calif., (1942).
W. L. Turner, Jr., Assoc. Ed. Railway Age, Chicago, (1946).

S. G. Urban, Arch., T. & P. Ry. Co., Dallas, Tex., (1947).

W. H. Vance, Asst. Engr. M. of W., Mo. Pac. Lines, St. Louis, Mo., (1910).
E. C. Vandenburgh, Engr. of Mtce., C. & N. W. Ry., Chicago, (1925)
J. L. Varker, Div. Engr., D. & H. R. R., Carbondale, Pa., (1936)
H. L. Veith, B. & B. Supv., So. Ry., Birmingham, Ala., (1942).
R. E. Ventress, Mast. Carp., G. M. & O. Ry., Bloomington, Ill., (1946)
T. M. Von Sprecken, Asst. Chf. Engr., So. Ry., Washington, D. C., (1938)
J. S. Vreeland, Sales Repr., Ry. Engr. & Mtce., New York, (1940).

R. E. Wait, Supv. B. & B., Wabash R. R., Decatur, Ill., (1923).
G. Walker, Asst. B. & B. Supv., Mo. Pac. Lines, San Antonio, Tex., (1946).
G. P. Walker, Supv. B. & B., Mo. Pac. Ry., Monroe, La., (1929).
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T. J. Webster, Mast. Carp., C. R. I. & P. Ry., Kansas City, Mo., (1941).
D. E. Weidner, For. Carp., Reading Co., Harrisburg, Pa., (1947)
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J. W. Westwood, Div. Engr., N. Y. C. Lines. Detroit., (1941)
J. C. White, Div. Engr., N. Y. C. Lines, Indianapolis, Ind., (1947)
L. H. White, B. & B. Supv., Ill. Cent. R. R., Carbondale, Ill., (1946).
S. White, Senior-Asst. B. & B. Supv., So. Pac. Co., El Paso, Tex., (1942)
B. M. Whitehouse, Ch. Fire Insp., C. & N. W. Ry., Chicago. (1927).
R. V. Wickman, Supv. B. & B., B. & A. Ry., Pittsfield, Mass., (1948)
A. Wiitala, Gen. For., B. & B., L. S. & I. Ry., Marquette, Mich., (1941).
Wm. Wilbur, Div. Engr., C. & N. W. Ry., Green Bay, Wis., (1947).
N. H. Williams, B. & B. Supv., D. & H. R. R., Oneonta, N. Y., (1947)
W. T. Williams, B. & B. Supv., T. & N. O. R. R., Ennis, Tex., (1947)
L. C. Winkelhaus, Arch. Eng., C. & N. W. Ry., Chicago. (1934).
J. J. Winn, Supv. B. & B., B. & M. R. R., Boston, Mass., (1946).
H. A. Wistrich, Asst. Ch. Engr., L. V. R. R., New York, (1938).
H. O. Wray, Engr. M. W. & S., Tex. City Trml. Ry., Texas City, Tex., (1939).
H. Wrights. Supv. B. & B., Mo. Pac. Ry., Little Rock, Ark., (1929)

J. E. Yewell, Engr. B. & B., B. & L. E. R. R., Greenville, Pa., (1941).
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H. M. Large, Mast. Carp., Penn. R. R., 511 Geddings Ave., Grand Rapids, Mich., (1908)
P. P. Lawrence, Supt. B. & B., N. Y. C. & St. L., Tipton, Ind., (1928)
A. Leslie, Div. For. B. & B., M. C. R. R., St. Thomas, Ont., Can., (1915)
E. A. LeWald, Engr. Inspr., G. C. & S. F. Ry., Galveston, Tex., (1925)
S. Lincoln, Gen. For. B. & B., G. C. & S. F. Ry., 1903 Harrison Ave., Beaumont, Tex., (1927)
C. G. Lindstrom, For. B. & B., C. M. St. P. & P. Ry., Rockwell City, Iowa. (1924)
C. R. Lyman For. B. & B., Central Vermont Ry., Waterbury, Vt., (1913)
E. M. McCabe, Supv. B. & B., B. & A. R. R., Pentoosuc Lake, Pittsfield, Mass., (1915)
A. L. McCloy, Supv. B. & B., P. M. Ry., 1714 Fitzhugh, Saginaw, Mich., (1913)
G. G. McCue, Supv. B. & B., G. T. R. R., 369 Main St., Ottawa, E. Ont., (1913)
H. A. McElhinney, B. & B. Mast., C. N. Ry., 9 Beech St., Halifax, N. S., (1923)
A. G. McKay, Supv. B. & N. Y. N. H. & H. R. R., 11 Pine Island Road, Jupiter Pt. Groton, Conn., (1915).
T. D. McMahon, Architect, G. N. Ry., 223 Lake Ave., White Bear Lake, Minn., (1918)
E. L. Mead, Div. Engr., C. & N. W. Ry., 536 N. E. 69th St., Miami, Fla., (1923)
J. Mellgren, For. W. S., C. & N. W. Ry., 523 N. Caldwell Ave., Eagle Grove, Iowa (1913)
A. Montzheimer, Chf. Engr., E. J. & E. Ry., 245 LaGrande Blvd., Elgin, Ill., (1897)
A. B. Nies, Architect, Mich. Cent. R. R. (NYC), 408 Third St., Jackson, Mich., (1915)
W. J. O'Brien, Dist. Carp., C. M. St. P. & P. Ry., 3413 W. Wells St., Milwaukee, Wis. (1919)
J. A. Owen, For. B. & B., D. & M. Ry., E. Towas, Mich., (1915)
W. V. Parker, Gen. For. B. & B., St. L. S. S. W. Ry., Route 6, Box 96, Memphis, Tenn., (1911)
P. Paulson, Supv. B. & B., C. & N. W. Ry., 547 Simmons Ave., S. E., Huron, S. D., (1923)
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D. L. Rehmert, Mast. Carp. Penn. R. R., 104 W. 3rd Ave., Columbus, Ohio. (1918).
J. Robinson, Supv. B. & B., P. M. R. R., 845 Gladstone S. E., Grand Rapids, Mich., (1910)
O. F. Rowland, Asst. Engr., D. & H. R. R., c/o Industrial Farm, Canaan, N. Y., (1923)
F B. Scheetz, Asst. Engr., Mo. Pac., Ry., 3930 Connecticut Ave. Washington, D. C., (1905)
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J. VonSchrenk, Const. Tbr. Engr., D. L. & W. Ry., Tower Gr. and Flad Ave., St. Louis, Mo., (1916)
W. H. Walden, Rdm., Sou. Ry., 1012 Porter St., Richmond, Va., (1920)
L. A. Warren, Supv. B. B., So. Pac. Co., Sacramento, Calif., (1929)
W. Watson, Supv., B. & B., E. J. & E. Ry., Joliet, Ill., (1930)
F. W. White, Supv. B. & B., L. V. R. R., 409 S. Wilbur Ave., Sayre, Pa., (1915)
W. E. White, Gen. For., A. T. & S. F. Ry., Chanute, Kans., (1920).
J. J. Wishart, Supv., B. & B., N. Y. N. H. & H., 21 Elmlawn Rd., Braintree, Mass., (1915)
C. F. Womeldorf, Asst. Engr., C. & N. W. Ry., 111 No 12th St., Norfolk, Nebr., (1917)
C. W. Wright, Mast. Carp., L. I. R. R., 67 Nassau Parkway, Oceanside, N. Y., (1908)
H. Wuerth, Div. Engr., C. M. St. P. & P. R. R., Savanna, Ill., (1919)
R. C. Young, Ch. Engr. L. S. & I. R. R., 719 Pine St., Marquette, Mich., (1907).
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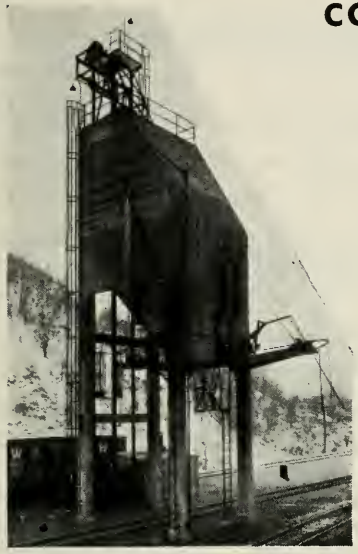

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F. L. Thompson, Vice Pres., I. C. R. R., Chicago, (1908)

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L. Adams, Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1943).
C. H. Anderson, Mgr., R. R. Sales Div., Armco Drainage & Metal Products, Inc., 206 Auditorium Bldg., Cleveland, Ohio, (1946).
W. P. Arnold, Asst. to V.-P. (Wood Preservg. Div.), Koppers Co., Inc., Pittsburgh, Pa., (1946).
K. C. Avery, 15-559 Woodworth Ave., Detroit, Mich., (1946).

G. H. Bailey, Mgr. R. R. Div., Morrison-Knudsen Co., 411 W. 5th St., LosAngeles, Calif., (1946)
D. L. Baker, V.-P., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
A. E. Bardwell, West. Div. Mgr., Fabreeka Products Co., 225 N. Wabash Ave., Chicago, (1946).
T. E. Bart, Designing Engr., The Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio, (1946).
G. R. Betts, Mgr. R. R. Sales, Armco Drainage & Metal Prod., Inc., 310 S. Michigan Ave., Chicago, (1946).
D. B. Bishop, Sales Eng., Dearborn Chemical Co., 1512 Farmers Bank Bldg., Pittsburgh, Pa., (1946).
J. D. Bolton, J. D. Bolton & Co., 20 N. Wacker Dr., Chicago, (1946).
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C. R. Boulton, R. R. Contractor, 15 E. Town St., Columbus, Ohio, (1946).
H. R. Boyd, Sargent & Boyd, 22839 Beech St., Dearborn, Mich., (1946).
E. S. Burford, V.-P., Consolidated Machinery & Supply Co., Ltd., 2031 Santa Fe Ave., Los Angeles, Calif., (1946).
A. C. Burhenn, Paint Engr., The Sherwin-Williams Co., 3170 E. Pico, Los Angeles, Calif., (1945).
J. P. Burkey, Con. Engr., Union Metal Mfg. Co., 2421 Plymouth Ave., Columbus, Ohio, (1942).

J. E. Carroll, Mgr. Constr. Eqpt. Div., Harron Rickard & McCone Co. of Sou. Calif., 3850 Santa Fe Ave., Los Angeles, Calif., (1945).
K. H. Charlson, V.-P., Cunningham-Rudy Co., 3087 W. Grand Boul., Detroit, Mich., (1946).
K. J. Clapp, Asst. Sales Mgr., Homelite Corp., Port Chester, N. Y., (1946).
H. S. Claybaugh, Div. Engr. Armco Drainage & Metal Prod., Inc., 171 - 27th Ave., S. E., Minneapolis, Minn., (1946).
R. R. Clegg, Dist. Sales Mgr., American Lumber & Treating Co., 332 S. Michigan Ave., Chicago, (1946).
M. Coburn, (retired) Const. Agt., J. D. Bolton & Co., 4117 Park Ave., Indianapolis 5, Ind., (1946)
G. B. Coffey, Div. Mgr., A. M. Byers Co., Chicago 3, (1946)
C. M. Colvin, Constr. Supt., Armco Drainage & Metal Products, Inc., 7th & Parker Sts., Berkeley, Calif., (1945).
W. E. Crawford, Pres., George Vang, Inc., 623 Grant Bldg., Pittsburgh, Pa., (1946).
D. M. Crooks, Field Engr., Douglas Fir Plywood Assoc., 1707 Daily News Bldg., Chicago, (1946).
E. T. Cross, V.-P., Armco Drainage & Metal Producs, Inc., Middletown, Ohio, (1946).
T. D. Crowley, Pres., Thos. D. Crowley & Co., 6 N. Michigan Ave., Chicago, (1946).

V. W. Davis, Mgr. R. R. Sales, Armco Drainage & Metal Prod. Inc., 122 Michigan Ave., Decatur, Ga., (1946)
F. W. Dayton, 4614 No. Paulina St., Chicago, (1941)
G. E. Detzel, George E. Detzel Co., 2303 Gilbert Ave., Cincinnati, Ohio, (1945).
G. J. Diver, V.-P., Morrison Metalweld Process, Inc., 1437 Bailey Ave., Buffalo, N. Y., (1946).
F. J. Duffie, Gen. Supvr., Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
W. D. DuLac, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 544 New Center Bldg., Detroit, Mich., (1945).
K. O. Duncan, Duncan Hydraulic Roc-Jak, 1350 Wright St., Los Angeles 15, Calif., (1947)

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C. R. Ehni, Lubr. Engr., The Texas Co., 4126 Bellefontaine Ave., Kansas City, Mo., (1945).
L. T. Ericson, Ch. Engr., The Jennison Wright Corp., Toledo, Ohio, (1948).
H. Eschenbrenner, Pres., Universal Concrete Pipe Co., 36 Ashbourne Rd., Columbus, Ohio, (1946).
F. W. Evinger, R. R. Repr., The Patterson Sargent Co., 1882 S. Normal Ave., Chicago, (1946).

J. D. Faylor, Constr. Supt., Armco Drainage & Metal Prod., Inc., 444 Insurance Exchange Bldg., Des Moines, Iowa, (1946).
P. Fields, Sales Div., Detroit Graphite Co., 3228 N. Broadway, St. Louis, Mo., (1946).
A. J. Filkins, Pres., Filkins & Sons, 308 W. Washington St., Chicago, (1927)
F. Fix, Sales Mgr., Transp. Dept. Cent. Div., Johns-Manville Sales Corp., 1530 Guild Hall Bldg., Cleveland, Ohio, (1946).
L. Flanagan, Detroit Graphite Co., 1500 S. Western Ave., Chicago, (1937).
R. L. Fletcher, Strl. Engr., Timber Engineering Co., 1319—18th St., N. W., Washington, D. C., (1947)
A. O. French, Mgr. R. R. Sales, Mall Tool Co., 7740 S. Chicago Ave., Chicago, (1946).

Goerder, Supt., George Vang, Inc., R. R. Contractors, 623 Grant Bldg., Pittsburgh, Pa., (1946)

R. J. Haxton, Sales Engr., Scotchlite Div., Minnesota Mining & Mfg. Co., 631 S. Anderson St., Los Angeles, Calif., (1946).
W. R. Hedden, Gen. Supt. of Constr., Roberts & Schaefer Co., 307 N. Michigan Ave., Chicago, (1946).
J. F. Hickey, Pres., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
R. R. Howard, Div. Mgr., Fabreeka Products Co., Inc., 6432 Cass Ave., Detroit, Mich., (1946).
C. A. Hubbell, Sales Mgr., Consolidated Machinery & Supply Co., Ltd., 2031 Santa Fe Ave., Los Angeles, Calif., (1946)
D. A. Hultgren, Pres., David A. Hultgren Co., 80 E. Jackson Blvd., Chicago, (1945).

A. W. Johnson, Asst. Engr., Deleou & Cathers Co., 150 N. Wacker Dr., Chicago, (1942).
E. O. Johnson, Dist. Mgr., Bowser, Inc., Ft. Wayne, Ind., (1946).
E. R. Johnson, Salesman, Harron, Rickard & McCone, 3850 Santa Fe Ave., Los Angeles, Calif., (1945).
H. E. Johnston, Sales & Ser. Engr., Dearborn Chemical Co., 205 E. 42nd St., New York, (1947)
J. E. Kalinka, Vice-Pres., Roberts & Schaefer Co., 307 N. Michigan Ave., Chicago, (1946).
B. D. Keatts, Reg. V.-P., Intrusion-Prepakt, Inc., 746 Union Commerce Bldg., Cleveland, Ohio, (1946).
G. D. Kemler, V.-P., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
A. L. Krukenberg, Pomona Pump Dealers, 2646 Norwalk Blvd., Norwalk, Calif., (1946)
F. H. Kuhlmann, Dist. Mgr., Dearborn Chemical Co., 1218 Oliver St., St. Louis, Mo., (1946).

J. W. Lacey, Gen. Supvr., The Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
D. A. Leach, Dist. Sales Mgr., Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago, (1946).
C. L. LeDuc, Field Sales Mgr., Acorn Refining Co., c/o Hotel DeSoto, St. Louis, Mo., (1946).
T. Lehon, V.-P. & Gen. Mgr., The Lehon Company, 4425 S. Oakley Ave., Chicago, (1937).
F. M. Lehrman, Engr., Reynolds Metals Co. (Ry. Suppl. Div.), 64 E. Jackson Blvd., Chicago, (1945).
F. Leypoldt, Jr., Pres., Carbolineum Wood Preserving Co., 528 W. Highland Ave., Milwaukee, Wis., (1945).
L. A. Luther, Serv. Engr., Ingersoll-Rand Co., 1121 Hamilton, Palo Alto, Calif., (1945).
C. A. Lyon, Dist. Mgr., Master Builders Co., 228 N. LaSalle St., Chicago, (1945).

B. J. Many, Pres., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
W. M. Marshall, Serv. Engr., Independent Pneumatic Tool Co., 355 Loma Ave., Long Beach, Calif., (1946).
C. L. Martin, c/o H. P. Martin & Sons, Box 475, Owensboro, Ky., (1946).
W. L. McDaniel, V.-P., Massey Concrete Products Co., 122 S. Michigan Ave., Chicago, (1945).
E. C. McFadden, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 11110 Longwood Dr., Chicago 43, (1945)

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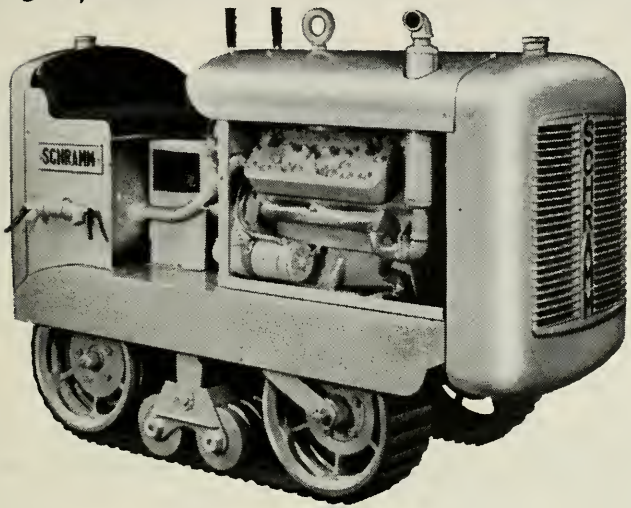

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E. J. McGehee, Vice-Pres. & Sales Mgr., Koppers Co., Inc. (Wood Pres. Div.), 700 Koppers Bldg., Pittsburgh, Pa., (1946).
G. P. McGregor, Dist. Mgr., Panther Oil & Grease, 840 N. Main St., Ft. Worth, Tex., (1946)
C. J. McNally, Gen. Mgr., Cement Gun Co., Inc., 1520 Walnut St., Allentown, Pa., (1945).
C. A. McTaggart, State Sales Mgr., N. & S. Dak., Armco Drainage & Meal Products, Inc., 705 National Bank Bldg., Sioux Falls, S. D., (1946)
G. McVay, Mgr. R. R. Sales Div., The Ruberoid Co., 307 N. Michigan Ave., Chicago 1, (1937)
J. Wallace Miller, Pres., W-M Corp., 608 S. Dearborn St., Chicago, (1946).
H. K. Mills, Pres., Zitterell-Mills Co., Webster City, Iowa, (1946).
J. H. Minton, The Minton Construction Co., Swetland Bldg., Cleveland, Ohio, (1946).
H. Montgomery, Dist. Mgr., The Master Builders Co., 1340 E. 6th St., Los Angeles, Calif., (1946).
Z. J. Montgomery, Arco Co. of California, Ltd., Los Angeles, Calif., (1945).
Wm. Moorhead, Service Engr., A. C. Horn Co., 1318 S. Main St., Los Angeles, Calif., (1946)
G. W. Morrow, Sales Mgr. R. R. Div., Worthington Pump & Machinery Corp., 400 W. Madison St., Chicago, (1945).
H. M. Morton, Sales Eng. R. R. Div. Johns-Manville Corp., 1207 Architects Bldg., Los Angeles, Calif., (1945).
H. Mull, V.-P. Sales, Warren Tool Corp., 2119 Bankers Bldg., Chicago, (1946).
J. K. Murdock, Vice-Pres., The Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio, (1946).

L. H. Needham, Vice-Pres., The Penetryn System, Inc., 2294 Scranton Rd., Cleveland, Ohio, (1946).
W. L. Norman, Field Engr., Sullivan Machinery Div., Joy Mfg. Co., 2900 Santa Fe, Los Angeles, Calif., (1946).

P. A. Orton, Jr., V.-P., Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago, (1946).
R. I. Oswald, Lubr. Engr., The Texas Co., 141 D So. Canon Dr., Beverley Hills, Calif., (1945).

G. H. Paris, R. R. Repr., Port'and Cement Assoc., 33 W. Grand Ave., Chicago, (1945).
R. Patterson, Vice Pres., Instrusion Prepakt, Inc., 80 E. Jackson Boul., Chicago 4, (1946)
D. D. Powers, Sales Engr., Dearborn Chemical Co., 1101 Union Central Bldg., Cincinnati 2, Ohio, (1947)
C. C. Rausch, Asst. Vice-Pres., Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, (1945).
G. H. Redding, Pres., Massey Concrete Products Co., 122 S. Michigan Ave., Chicago, (1946).
W. T. Reeves, Const. Engr. Strl. Steel Dept., Robert W. Hunt Co., 172 W. Jackson Boul., Chicago, (1924)
H. H. Richardson, Asst. Vice-Pres., National Aluminate Corp., 6216 W. 66th Pl., Chicago, (1941).
H. E. Robertson, Mgr., The Robertson Co., 730 E. Gage Ave., Los Angeles, Calif., (1946).
W. O. Robertson, Div. Sales Engr., Armco Drainage & Metal Prod., Inc., Box 1657, Baltimore, Md., (1946).
L. R. Robinson, Pres., Pittsburgh Pipe Cleaner Co., 133 Dahlem St., Pittsburgh 6, Pa., (1945).)
W. H. Rockefeller, Insulation Engr. & Contract Mgr., Marine Engineering & Supply Co., 941 E. 2nd St., Los Angeles, Calif., (1946).
O. C. Rome, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).

B. H. Sargent, Sargent & Boyd, 22839 Beech St., Dearborn, Mich., (1946).
O. M. Saxton, Dist. Chgo. Mgr., Timber Structures, Inc., 120 S. LaSalle St., Chicago, (1945).
J. M. Scott, The Arco Co., 614 Delaware St., Scranton, Penna., (1945).
J. F. Seiler, Prin. Engr., Ser. Bur.-American Wood Preservers Assn., 111 W. Washington St., Chicago, (1931).
J. W. Shoop, Mgr. R. R. Sales Dept., The Lehon Co., 4425 S. Oakley Ave., Chicago, (1945).
J. E. Simkins, Mgr., Jas. E. Simkins, 5408 S. Western Ave., Los Angeles, Calif. (1945).
B. S. Snow, Pres., T. W. Snow Construction Co., 9 S. Clinton St., Chicago, (1946).
C. E. Southwick, Factory Repr. Homelite Corp., (Port Chester, N. Y.), 624 S. Anderson, Los Angeles, Calif., (1945).
P. C. Spears, Vice-Pres., General Dredging Co., Inc., 2200 La Fontain St., Ft. Wayne, Ind., (1946).

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T. R. Stevens, Sales Engr., Tran. Rock Material & Engineering Co., 4016 Flad, St. Louis 10, Mo., (1947)
G. W. Stierer, Mgr., Structural Steel Dept., Robert W. Hunt Co., 175 W. Jackson Blvd., Chicago, (1946).
W. J. Storen, Jr., Pres., W. J. Storen Co., 2411 - 14th St., Detroit, Mich., (1946).
L. O. Stratton, Lloyds Ry. Supplies, 227 U. S. Natl. Bank Bldg., Denver, Colo. (1947).

W. C. Thatcher, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).
N. Thompson, V-P., Homelite Corp., Port Chester, N. Y., (1946).
J. W. Todd, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 3034 Washington Ave., St. Louis, Mo., (1945).
R. N. Tracy, Div. Engr., Armco Drainage Metal Products, Inc., P. O. Box No. 2170, Denver 1, Colo., (1946)
F. W. Truss, Sales Engr., Armco Drainage & Metal Prod., Inc., 815 Ambassador Bldg., St. Louis, Mo., (1946).

F. S. Ulrich, Ind. Mgr., Sherwin-Williams Co., 1450 Sherman Ave., Oakland, Calif., (1946).

R. G. VandenBoom, Pres. & Treas., Pacific Union Metal Co., P. O. Box 2616, Terminal Annex, Los Angeles, Calif., (1946).

R. Wagner, Asst. Gen. Supt. of Constr., Roberts & Schaefer Co., 301 N. Michigan Ave., Chicago, (1946).
R. W. Walb, Pres., General Dredging Co., Inc., 2200 LaFontain St., Ft. Wayne, Ind., (1946).
K. J. Weir, W-M. Corporation, 680 S. Dearborn St., Chicago 5, (1940)
V. E. West, Pres., Stacco Products, Inc., 1207 - 19th Ave., Oakland, Calif., (1946).
B. E. Whipple, Sales Eng., Pacific Union Metal Co., P. O. Box No. 2616 Term. Annex, Los Angeles, Calif., (1946).
E. R. Williams, Pres., Williams Waterproofing & Painting Co., 707 Heliotrope Dr., Los Angeles, Calif., (1945).
E. R. Wolf, Sales Engr., Marine Engineering & Supply Co., 941 E. 2nd St., Los Angeles, Calif., (1946).
B. R. Wood, c/o The Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio, (1937).

R. W. Young, Jr., R. W. Young Mfg. Co., 20 N. Wacker Dr., Chicago, (1946).

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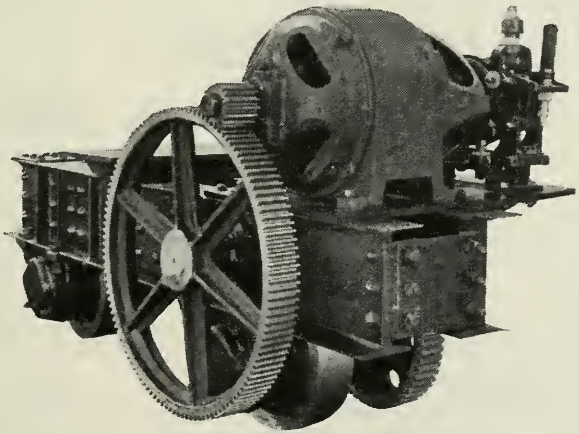

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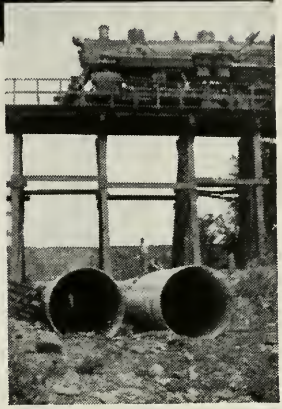

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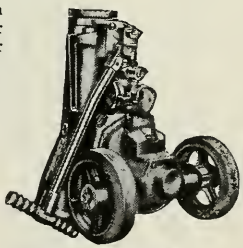

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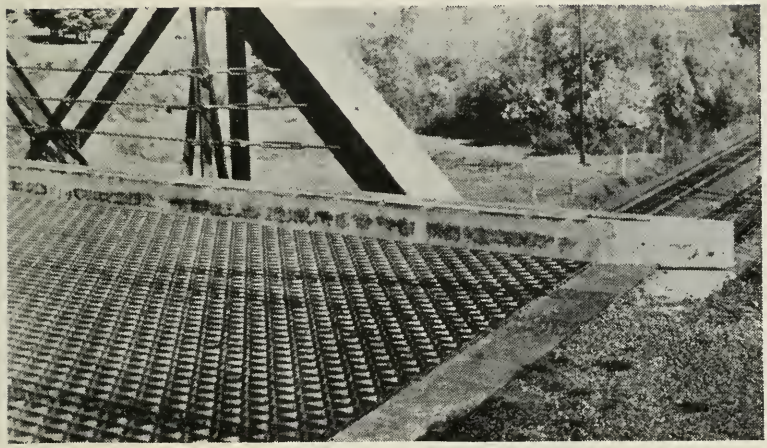

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Chicago Pneumatic Tool Company, New York.
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Koehring Company, Milwaukee, Wis.
Lehon Company, Chicago.
Massey Concrete Products Company, Chicago.
Master Builders Company, Cleveland, Ohio.
Overhead Door Corporation, Hartford City, Ind.
Owens-Illinois Glass Company, Toledo, Ohio.
Oxweld Railroad Service Company, Chicago.
Pittsburgh Pipe Cleaner Company, Pittsburgh, Pa.
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List of Advertisers

Air Reduction 100
American Bridge Company 51
American Lumber & Treating Company 57
Armco Drainage & Metal Products, Inc. 105
Baker & Hickey Co., The 105
Bates & Rogers Construction Corporation 107
Boulton, C. R. 59
Buda Company, The 63
Dearborn Chemical Company 117
Detzel, George E., Company 65
Duff-Norton Manufacturing Company, The 107
Electric Tamper & Equipment Co. 67
Fabreeka Products Company, Inc. 69
Fairmont Railway Motors, Inc. 71
Hunt, Robert W., Company 115
Irving Subway Grating Company, Inc. 109
Koppers Company, Inc. 55
Lehon Company, The 109
Lufkin Rule Company, The 111
Many, B. J., Company, Inc. 73
Massey Concrete Products Company 111
Master Builders Company, The 75
National Aluminate Corporation 77
National Boiler Washing Systems 113
National Water Main Cleaning Company 79
Ogle Construction Company 81
Overhead Door Corporation 83
Oxweld Railroad Service Company, The 85
Patterson, W. W., Company 113
Pittsburgh Pipe Cleaner Company 87
Railroad Products Company 89
Rails Company, The 91
Roberts & Schaefer Co. 93
Sargent and Boyd 115
Schramm, Inc. 97
Snow, T. W., Construction Company 95
Timber Engineering Company 53
Torrington Company, The, Bantam Bearings Division ..... Inside Back Cover
Vang, George, Inc. 99
United States Steel Corporation 51
Wood Products Company 101
Young, R. W., Manufacturing Company 103
Zone Company, The 60, 61

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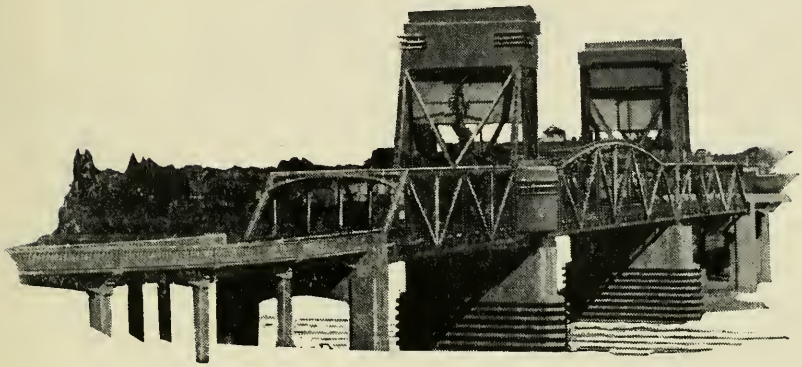

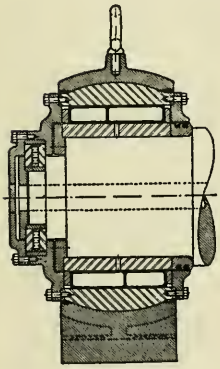

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